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**VOL. XII. NEW YORK, AUGUST 11, 1888. No. 6.**

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**New Cable Rates.** THE new cable rates will, we think, recommend themselves to the public as reasonable. There was nothing in the companies on the "war tariff" basis, and even now dividends will not be high, but as Sir John Pender neatly puts it, the state of affairs will be more creditable to the cable officers as business men. Besides, in the fact that the Commercial Cable Company still remains outside the pool lies a guarantee against exorbitant charges hereafter.

**The Western Union Deal.** LAST week we made note of rumors then very secretly in circulation as to the intention of Mr. Jay Gould to sell out his telegraph properties or make some disposition of them that would relieve him of bother and harassment in regard to them. During the week the reports were strenuously denied, but now again they crop up with more body and circumstantiality than before. As we then said, the case is one presenting many features of probability, and the public may as well be prepared for some notable changes in regard to the control of the telegraph in this country.

**Water-Jet Telephones.** THE admirable investigations of Mr. C. A. Bell on sensitive jets as receivers and transmitters of sound waves reported in these pages two or three years ago, have at last been applied to the construction of a commercial telephone transmitter. The instrument, which is described and illustrated in another column, deserves special attention on account of an advantage which it possesses over the carbon transmitter for this purpose. It is well known that the E. M. F. of the sending battery is limited to one or two cells with the ordinary transmitter, and cannot be much exceeded even in the Hunnings type, on account of the burning and the lack of distinctness caused by the sparks. With the water jet transmitter this is obviated, so that an increased number of cells can be employed with corresponding effect.

**Fac-Simile Telegraphs.** ONE of the most persistent things in connection with telegraphy is the attempt to bring about autographic transmission, and from the time of Casselli and Bain, down to the present day, efforts have been made to accomplish the object in a commercial manner. We noted lately the employment of the principle of varying the current in two circuits, which act upon armatures at right angles to each other, whose motions are transmitted to a record pen, in conformity with the motions given to the pen at the transmitting station where the pen acts upon resistances placed in the circuit. In this issue we describe another method, that of Prof. Elisha Gray, of securing a fac-simile transmission, in which an entirely novel principle is employed. The apparatus is quite simple, and from the reports which have come to us it affords a practicable method. It is not probable that the system will supersede the present modes of telegraphy, but for special purposes, especially in connection with exchange work, it may have a widening field of usefulness.

**Dynamo Currents in Telegraphy.** WE illustrate on another page the description of a plant which has recently been installed on the plans of Mr. F. W. Jones, at the headquarters of the Postal Telegraph Company in this city, for the purpose of supplying dynamo currents to the quadruplex and other circuits. Although the main idea of such installations is not new, there are many novelties of practice in the present case, as might be expected of an electrician of Mr. Jones' ability and experience. Not only has ingenuity been shown in the details of the dynamo plant proper, but in the methods for introducing lamps into the circuits as resistances, and in rendering the manipulation and use of the currents at once convenient and economical. The relief from the care of tens of thousands of cells, and all the ills to which they are heir cannot easily be imagined or described, and the reliability of the service is described as such that by no conceivable combination of circumstances could the supply of current be interrupted. It is curious to note that there are no less than three sources of prime power in the installation described, two of steam and one of electricity, supplied from a street main. These, in connection with a duplicate set of machines, insure absolutely continuous operation.

**Size of Telephone Conductors.** WE would call the attention of our readers to a very interesting article, by Mr. David Brooks, on the proper size of telephone conductors, given in another column. Mr. Brooks shows by an interesting experiment the influence of increasing the size of the conductor, at the same time that its electro-static capacity is increased. Mr. Brooks, contrary to received opinions as dictated by the experience of recent years, thinks that the resistance of telegraph wires may, within quite large limits, be practically neglected, and that the electro-static capacity should be kept down by decreasing the size of the wire. This brings us to the consideration of the fact that there must be a mean between the resistance and the electro-static capacity of the wires, at which the best effects are obtainable. We would recall to our readers the experiments in this direction made by Dr. W. W. Jaques, who states that the ease with which telephonic conversation can be carried on over any circuit, whether made by a cable or pole lines, or both, depends first, on the total electrical resistance of the circuit joining together the two stations, and second, on the total electro-static capacity of the circuit; and the rule developed by Dr. Jaques is as follows: "No matter what may be the distance between two points, good business conversation may be carried on between them, provided they be connected by a pole line or cable, or both, the product of whose total resistance by its total capacity is less than 2,000 if transmitters of the Blake type be used, and less than 4,500 if transmitters of the Hunnings type be used." This rule which has been deduced as the result of experiment, has been found to be quite accurate.

**An American Pacific Cable.** UNLESS the United States soon builds a Pacific cable, it is likely that England and her colonies will do so; and it is not altogether improbable that we may have two cables laid across the Pacific Ocean at no distant date. It would seem as though one would be enough at present for all the business that may develop; but at the same time it is a question whether England, whose object in laying the cable would be largely strategical, would care to have one end of it landing in the United States, and, on the other hand, it is quite likely that there would be many objections advanced in this country against the use of a cable whose connections lay wholly within the territory of England and her possessions. But it does not appear unfair to assume that some of the eastern nations might prefer an American system of service—Japan, for example—while it is well known that Mr. Allen, secretary of the Corean Legation to the United States, has been in New York trying to arrange for direct telegraphic communication with San Francisco and the island kingdom. It begins to look as though there will soon be a race between American and English capital for the execution of the work; and there is good earnest of English desire to be in the lead, in the subsidies that are readily offered by the Australian colonies.

**Mr. Brown on His Defense.** IT was not to be expected that Mr. Harold P. Brown, whose letter on the danger of the alternating current had brought out so many answers, and among them several attacks upon his ability, would allow these replies to pass unheeded; and as the result, we have been treated to a series of experiments as to the effects of currents upon dogs. While we believe that much light can be shed on the subject by a systematic series of observations under the various conditions involved, the results thus far obtained, though a very good indication, must be taken with reserve. For there is a point which, it seems, demands consideration in reasoning from the effect of shocks upon dogs to similar shocks upon man. That is, aside from the question of resistance, into the case of man there enters the question of *morale*, which is absent in some animals, and varies considerably in many others. Thus, observation tends to show that the horse and the mule, animals which are naturally timid and nervous, succumb far more easily to current shocks than would have been the case with the dogs recently experimented upon. Hence, as we have remarked, the relatively fatal shock for the lower animals and for man is a question which cannot be decided off hand. As regards the apparent greater destructiveness to life of the alternating current, as seems to be shown by some of these experiments, the system has probably advanced too far for this to stay its progress at this time. However, we are glad to learn that the experiments just undertaken will be continued in a systematic manner. We may thus hope to learn something more definite on this vexed issue, so that safe and rational regulations can be based upon the results.

**The Corner in Copper.** THOSE who have have felt the pinch of the late rise in copper may derive some satisfaction from the information recently published on the subject by Mr. W. S. Lawson, one of the leading financial experts in London. Speaking of the French copper pool, Mr. Lawson says that a wilder transaction has not been recorded in the whole history of commerce. So fantastically absurd are the expectations of the pool, that he hardly deems them to be worthy of serious criticism. In fact, he says: "The Indian fakir who stands all day swallowing knives and swords has an easy task compared with the Paris syndicate in swallowing the greater part of the next three years' copper production of the globe. They propose to do in real earnest more than Gargantua attempted in burlesque." He goes on to point out that not only does the artificial inflation in price suffer from new sources of supply, but that in some industries copper has been wholly abandoned for the present, and that in others the quantity of old copper which has been brought out to throw on the market and still promises to come forward is a surprise. He holds, moreover, that the phrase "visible supply" is altogether a fiction in this case, and that there are undoubtedly enormous quantities of the metal held back out of reach of inconvenient statistics. If there be any foundation for such views, and Mr. Lawson's position certainly gives them very great importance and authority, a break in the market may be expected sooner or later, and probably soon. It would not take long to convince speculators of the truth of this statement, so that even if the market did not break by its own weight immediately, there would be bold and wealthy enough capitalists ready to go in for a winning campaign on the bear side. Out of this condition of affairs, consumers, among whom we may class all engaged in the electrical arts, will find consolation and encouragement as to a return to reasonable rates; and we trust that they will not be disappointed.

### The Gray Telautograph.

For some time past Prof. Elisha Gray, the well known inventor of the system of harmonic multiple telegraphy, has been at work on a new system of telegraphic transmission, the object of which is the fac-simile reproduction by telegraphy of the handwriting of the sender of a dispatch. The idea of fac-simile telegraphy is, of course, not novel, and has been carried out in several ways, but the new system of Professor Gray is based on quite original and simple methods.

The system consists primarily of two instruments, a receiver and transmitter, each provided with a pen. The transmitting pen is connected to operate circuit making and breaking devices, termed "interrupters," located in two electric circuits and arranged to interrupt the currents passing over the respective circuits at short intervals, producing current pulsations as the pen is moved in two directions crosswise of each other in forming characters, the number of pulsations in the respective circuits being determined by the distance which the pen is moved in the respective directions. These two circuits pass through the receiver and include two pairs of "receiving magnets," the armatures of which act to impart a step-by-step movement to the receiving pen in two directions crosswise of each other, the number of steps in each direction being determined by the number of times the respective circuits are interrupted. By this means the movements of the transmitting pen in the two directions operate through the interruptions in the currents passing over the circuits to impart corresponding movements to the receiving pen, and thus reproduce the matter written by the operator.

The accompanying illustrations, Figs. 1 and 2, show respectively a general plan of the transmitter and receiver. The transmitting pen *A* is connected at its point to two cords or other flexible connections *F G*, which extend horizontally at right angles to each other, and operate the two circuit making and breaking devices *B C*, termed the "interrupters," located in the two main circuits, connected to to *B* and *C*. The arrangements is such that as the pen *A* is moved from left to right and vice versa the circuit of *B* is made and broken repeatedly in quick succession, producing pulsations therein varying in number with the linear extent of the movement of the pen, and varying in speed of succession with the rapidity of such movement; while, as the pen is moved up and down in forming the characters, the circuit of *C* is interrupted and pulsations produced therein in the same manner.

The two interrupters *B C* are exactly similar in construction.

Each of the cords *F G* is wound upon a small drum upon a shaft to which one wire of the circuit is connected. The shaft is provided with an arm, the end of which carries a brush which sweeps in contact with the face of a metallic disc, to which the other wire of the circuit is connected. The face of the disc over which the brush sweeps is provided with insulating strips, so that as th brush sweeps over the face of the disc in either direction the current passing over the circuit in which the brush and disc are located will be made and broken repeatedly in quick succession. Each of the shafts is also provided with a second cord, which is wound upon the shaft in the direction the reverse of the cords *F G*, and is connected to a spring which keeps the cords *F* and *G* taut at all times. Each of the cords passes between guides located between the pen and the shafts, and the cords are provided with stops which engage with the guides and arrest the cords and limit the movement given to the shafts and brushes.

The transmitting instrument is also provided with two local circuits which include local batteries and a pair of pole-changers *D E*, which are located, respectively, in the main circuits of *B* and *C*, and which act to automatically change the polarity of the currents passing over the respective circuits whenever the movement of the transmitting-pen in either direction is reversed.

The pole-changers *D E* are connected to the two poles of the main batteries and to the two wires of the respective main circuits in the usual manner. For the purpose of operating the pole changers the cords *F G* pass around pulleys *P P* mounted upon shafts which operate circuit makers and breakers included in the respective local circuits. For this purpose the shafts are provided with arms which are frictionally connected to the shafts and have a limited movement between fixed stops. The arms and one of the stops of each arm are included in the respective local circuits, so that the rocking of the arms between their stops operates to make and break the local circuits, and thus operate the pole-changers *D E* to change the polarity of the currents passing over the main circuits of *B* and *C* at each vibration of the arms.

It will now be readily understood that as the pen makes the down strokes in forming the characters, the cord *F* will be unwound from the shaft of the interrupter *C*, revolving the shaft and moving the brush over the disc, and interrupting the current over that circuit repeatedly and in quick succession, the number and rapidity of the interruptions being determined by the speed and extent of the movement of the pen.

As the pen makes the upstrokes the spring will rewind the cord *F* and move the brush in the reverse direction, interrupting the current in the same manner.

It will also be understood that as the pen moves upward the cord passing around the pulley *P* will close the local circuit of the pole-changer *E* and send currents of one polarity over the line to *C;* and as the pen moves downward the pulley will open the circuit of the same pole-changer, so as to send currents of opposite polarity over the same line.

What has just been said with regard to the *C* circuit also applies to the ciruit of *B* when the pen is moved from right to left, the pole-changer *D* being then operated by the lower pulley and arm *B*, so as to change the polarity of the current according as the motion is from left to right, or vice versa.

We now come to the operation of the receiving instrument which is shown in Fig. 2. This consists of a pen con-

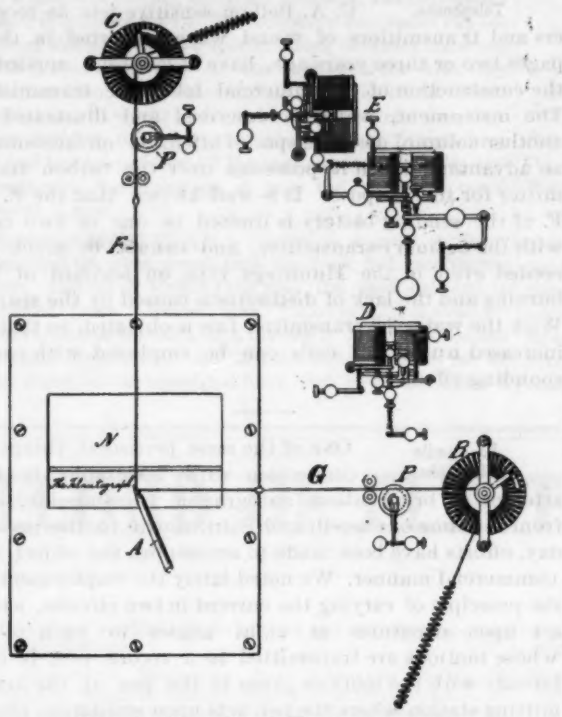



FIG. 1.—THE GRAY TELAUTOGRAPH.

nected by means of a tube with a supply of ink shown at the right adjoining the upper receiving magnets. The pen is connected to two rods which are placed at right angles to each other similar to the cords in the transmitter and are jointed so to have a free movement sidewise. One of these rods passes through the frame carrying the magnets *H H'*, which are included in the circuit of the interrupter *C* of the transmitter, and are provided with armatures which act upon the rod in such a manner as to impart a step-by-step movement to it in opposite directions, according as one or the other of the magnets is energized. The rod and the magnets *H H'* and their armatures are so arranged that the rod passes between the adjacent ends of the two parts of each armature in such a manner that when the two parts of either armature are moved toward

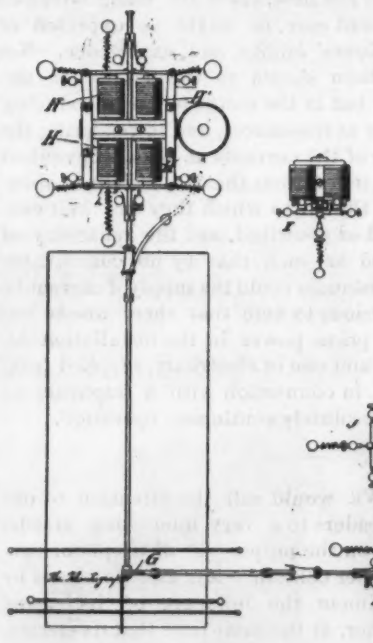



FIG. 2.—THE GRAY TELAUTOGRAPH.

each other they will act first to grip the rod between them, and being then moved toward the magnet, they will carry the rod with them and impart a corresponding movement to the pen *G*.

In connection with the magnets *H H* there is a polarized relay *I*, which is so arranged that when its armature is on one contact, due to a current coming over the line in a certain direction, it sends that current into the lower magnets *H H;* but when a current of opposite polarity comes over the line it is carried to the other stop, and the current is sent into the upper magnets, the lower magnets being then short circuited.

Now, it will be readily seen that when the pen *A* at the transmitting station is upward it sends current pulsations of one direction over the line. These are received by the relay *I* and sent into the lower magnets *H H*, which act as described above to grip and raise the rod to correspond exactly with the number of pulsations, which of course are determined by the amount of movement given to the transmitting pen *A*. When the latter is moved downward the current impulses are sent in similar way into the upper magnets, which grip and lower the rod in an analogous manner at each pulsation. The identical action also takes place with the current transmitted over the main line connected to the interrupter *B*, the current passing into the relay *I* and magnets *K K*, which act upon the rod at right angles to the first to move the pen sidewise in either direction.

From this it follows that any movement of the transmitting-pen in any direction oblique to the line or intermediate between these two directions will cause the receiving-pen to move in a corresponding direction, but with a compound movement made up of a number of steps taken at right angles to or crosswise of each other, the relative number of steps in each direction depending upon the obliquity of the direction in which the transmitting-pen is moved. By this means the receiving-pen is caused to substantially follow any movement of the transmitting-pen, and thus reproduce a fac-simile of whatever is written or traced by the latter.

The irregular or wavy character of the oblique lines made by the receiving-pen is said not to detract materially from the appearance of the writing, and is not sufficiently marked to prevent the handwriting of the person at the transmitting instrument from being readily recognized. The length of the steps with which the receiving pen is moved may be varied considerably; but the receiver is so adjusted that the pen takes from seventy-five to one hundred steps to the inch.

### On the Proper Size of Telephone Conductors.

BY DAVID BROOKS.

The long distance telephone company work metallic circuits of No. 16 American gauge between Philadelphia and New York, the length of conductors being slightly over 200 miles, the distance by line being 100 miles, four miles of which are under ground or water, making eight miles of conductors under ground and water. The telephones work well; far better, indeed, than the local service in the city for even as short a distance as one quarter of a mile, even if they use the same gauge conductor. With the metallic circuit the resistance is fully eight hundred times that of these short lines. I mention this to show that conductivity or low resistance has very little to do with good telephonic service. In the one instance we get rid of inductive disturbances, and in the other we do not.

Take an ordinary circuit, say one mile in length. Say that each receiver has a resistance of 100 ohms, and the induction coil 300 ohms, making a total of 400 ohms for the resistance of one instrument. Calling the conductor 20 ohms, we have a total resistance of 820 ohms in the circuit. Now, substituting a No. 21 gauge conductor, which has a resistance of about 70 ohms per mile, we have increased the resistance of the circuit about six per cent., and theoretically increased the magnetic effect six per cent. Now the No. 16 guage wire has twice the surface of the No. 21 gauge, and gathers twice the quantity of inductive disturbance. It has twice the electro-static capacity, and twice the retardation, if electro-static capacity and retardation are identical.

There is no trouble hearing the voice in these short circuits in either case, but the difficulty lies in getting distinct articulation. As an illustration we have a telegraph cable of 53 conductors on the Pennsylvania Railway between Broad and Thirty-second streets, a distance of 1½ miles. Twenty-eight of the conductors are in use, mostly for telegraphic purposes. The other 25 are idle. Using one of the wires with the telephone, it works fairly well, but if we bunch all the idle wires at each end and use them as a single conductor, we reduce the resistance of the conductor twenty-five fold, and we increase the inductive disturbances to that extent, and develop a noise resembling that of a million promiscuously-tuned Chinese gongs. We can get no speech over that bunched conductor.

There is another view which may be taken of the case and the effects ascribed to self induction, or as our European electricians now express it, "electro-static inertia." In reference to that phenomena I will quote from Dr. Oliver J. Lodge. He states: "There is a remarkable fact concerning electrical currents of varying strength, which has been lately brought into prominence by the experimental skill of Prof. Hughes, viz., that a current does not start or stop equally and simultaneously at all points in the section of a conductor, but starts at the outside first. The fact is naturally more noticeable with thick wires than with thin, and it is especially marked in iron wires." * * "To illustrate this matter further, rotate a common tumbler of liquid steadily for some time and watch the liquid, dusting powder, perhaps, over it to make it more visible, you will see first the outer layer begin to participate in the motion and then the next, and then the next, and soon, until at length the whole is in rotation. Stop the tumbler and the liquid also begins gradually to stop by a converse process." Again he states: "We learn from all this that whereas, in the case of steady currents, the sectional area and material of the conductor are all that need be attended to, the case is different when one has to deal with rapidly alternating currents such as occur in a telephone."

I am not familiar by practice or experiment with electrostatic inertia, but infer from what I read that it is unfavorable for the use of large sized conductors for telephone purposes. I am firmly in the belief, however, that small conductors, when used for ordinary lengths, are far preferable to those that have been heretofore employed. That for overhead wires strung on poles or house-tops, a phosphor bronze conductor, on account of its strength and small diameter, is far superior to iron or copper, because it can be made with very small diameter and yet have sufficient strength and conductivity. I believe also that there have been thousands or hundreds of thousands of dollars spent for copper which could have been saved and a better service obtained by using smaller sized conductors.

Before the conductors referred to in the iron pipe were connected to the overhead conductors, a number of experiments were made with telephones, using the iron pipe for the return circuit, so as to compare its effect with that of the complete copper metallic circuit. No inductive disturbance was perceived in either case, nor did the copper metallic circuit show any advantage over the circuits using the pipe for the return current. In the centre of the cable is a smaller sized wire, No. 18, American gauge, upon which we still use telephones; and although there are heavy dynamo currents upon four of the No. 16 conductors in the same cable, or group, the No. 18 conductor for telephone purposes using the pipe for the return circuit works much clearer and better than any of the circuits of the local telephone company, whose wires are strung upon poles or house-tops.

And this brings to my mind a suggestion of Oliver Heaviside, that electro-static inertia, or self induction, might be neutralized by mutual induction, since it does appear that the iron pipe has something to do with the good working of the telephone conductor.

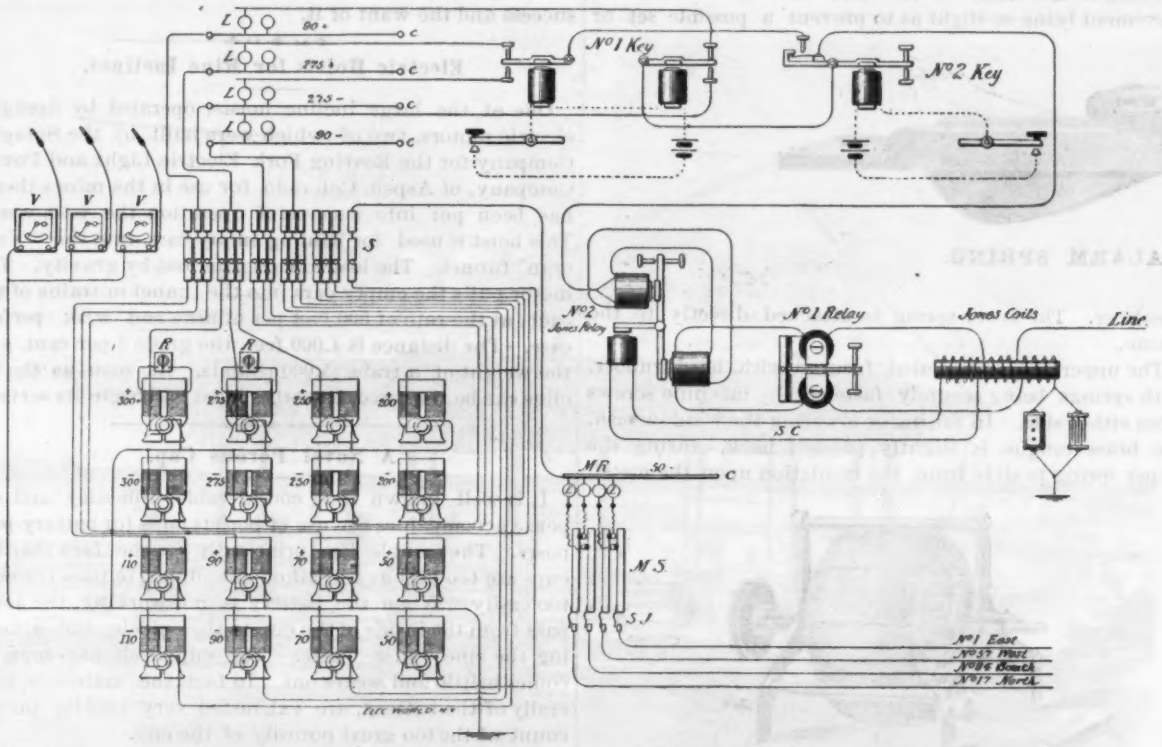



FIG. 2.—D'AGRAM OF CIRCUITS, JONES DYNAMO QUADRUPLEX SYSTEM.

## The Postal Telegraph Cable Company's Dynamo Telegraph System.

It is not to be wondered at that telegraph companies should take notice of the great improvements made during the past eigh. years in dynamo machines, and of their superiority over the very wasteful batteries which have been generally used everywhere, except in the New York main office of the Western Union Telegraph Company, for supplying currents for telegraph wires. No doubt competing companies, heretofore, have had a too precarious existence under the merciless havoc of cut rates, which always prevailed when any one had the audacity to attempt to give the public an independent telegraph service, to warrant an outlay for engines and a fixed plant of machines. The Postal Telegraph Cable Company, however, with a characteristic faith in the support of the public in an honest and fair competition, has installed a dynamo plant in its main office in New York, illustrations and description of which are presented herewith.

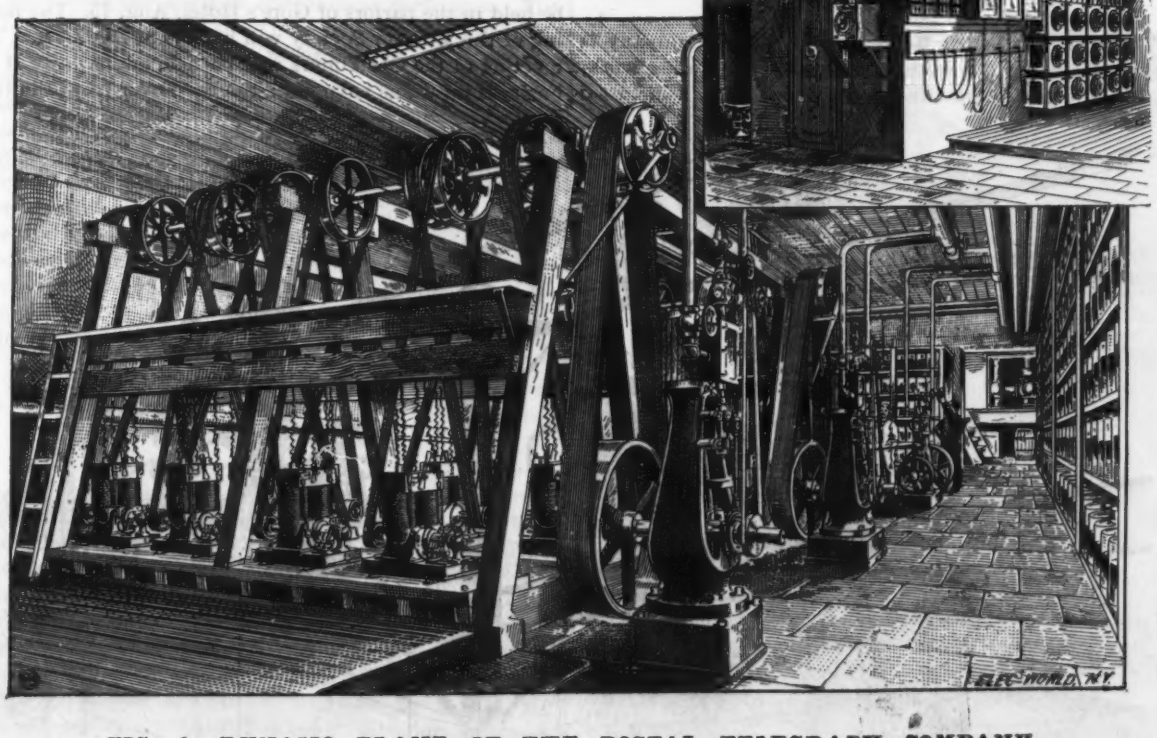


FIG. 1.—DYNAMO PLANT OF THE POSTAL TELEGRAPH COMPANY, NEW YORK, WITH SWITCHBOARD.

Ten thousand cells of Callaud or gravity battery have been displaced by the dynamos, and when account is taken of the twenty thousand wire connections of the battery, the difference of cost in favor of the dynamos in the consumption of zinc and coal, the labor and attention required, the unsteadiness of the battery currents as compared with those of the machines, the accidental openings of the batteries by reason of broken wires and defective zincs,—it will be seen that the change is sure to prove a very satisfactory one to the company.

The new system was devised entirely by Mr. Frank W. Jones, assistant-general manager and electrician of the company, and the reports from all quarters are unanimous as to the perfect manner in which it has operated from the very moment it was set in operation on July 16.

The machines, which are all of the familar Edison type, but specially wound, are located in a commodious basement at No. 187 Broadway. Each group of eight dynamos is arranged, as shown in Fig. 1, in a substantial A-shaped frame of yellow pine, the shafts running on top of the frame, a distance of 13 feet from the base. The length of the frame is 13 feet; width, 6 feet; size of timbers, 6 × 8 inches, morticed and held by bolts and nuts, so that the structure may be readily taken apart and removed at any time. All being self-contained, no jar or noise is perceptible, and a person near by is hardly aware of any motion. Two 10 horse-power New York Safety Power Company's engines are so connected up that either one is placed in action instantly by a Hill clutch to operate either one group or both at a moment's notice; a power belt connects both shafts from fixed pulleys and is arranged to be shifted to a loose pulley. One 6 horse-power engine of the same type as the above is in position alongside of the telegraph plant, and is connected up directly to a 40-light dynamo, which supplies incandescent lamps for lighting up the large and admirably arranged operating room on the fifth floor of Nos. 5 and 7 Dey street, directly in the rear of No. 187 Broadway, and also the office of Mr. Geo. F. Lewis, the cashier of the company, at No. 187 Broadway. An electric signal and speaking tube connects the dynamo room with the operating department, so that there is intimate communication at all times between them.

Referring to the diagram, Fig. 2, the sixteen machines are shown connected to a switch *S*. This switch is arranged so that each group of three positive or negative pressures come next to one another, and by a peg either one may be opened and the others pegged on to the lead from the switch to the lamp resistances shown over the switch, but which are placed for convenience in the operating room, as also are those shown on the right. To render the plan as perspicuous as possible, the diagram shows connections from the dynamos to only one set of quadruplex keys, through the lamp resistances *L L*, and one dynamo connection (the 50 negative machine) to the main switch *M S*, via the lamp resistances *M R*, and so on to four main wires, east, west, north and south.

On the left, marked *V V V*, are three voltmeters adjusted to take direct readings of any of the machines simply by inserting the pegs connected with the meters into a hole provided on the brass plates of switch *S*. In the field of each dynamo there is a resistance *R R* inserted in the field, so that the pressures may be varied at will. The two spare machines also have pole-changing switches to transpose the switch and ground leads, so as to enable either polarity to be instantly obtained; and in the field Mr. Jones has introduced a switch which places the field magnet wires either in multiple arc or series by one movement of the handle. The travel of the machines on their rails at right angles with the shaft is such that pulleys may be used, varying in size from 4 inches to 8 inches, for varying the speed without change of belt. Underwood cotton leather belting is used.

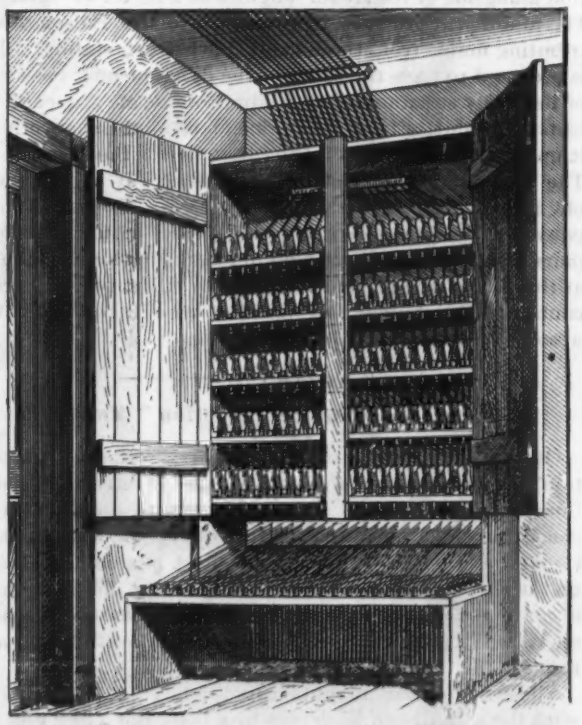
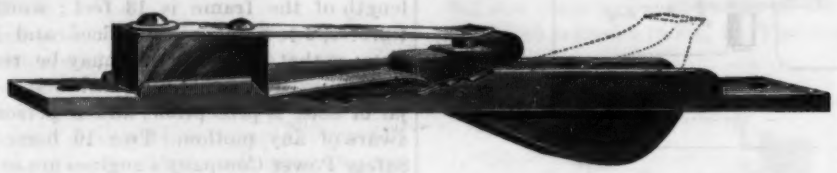


FIG. 3.—INCANDESCENT LAMP RESISTANCES POSTAL TELEGRAPH PLANT.

The dynamos were specially made for the Postal Company by the Edison Machine Works, of Schenectady, N. Y., under the superintendence of Mr. Samuel Insull and Mr. John Kruesi. The machines are very small in size and run noiselessly at speeds of from 1,200 to 2,000 revolutions per minute without any sparking, either with

or without load. Notwithstanding their diminutive proportions they will give a good, steady current running up to 25 ampères at a pressure of 50 volts at 2,100 revolutions.

The lamps in the resistances, Fig. 3, were arranged by Mr. J. W. Howell, of the Edison Lamp Company, and the voltmeters were designed by Mr. Kruesi. The lamp resistances are adjusted to 2 ohms to every 1 volt, so as to prevent any damage by overheating should the wires get crossed or grounded at or beyond the main switch-board.



A NEW BURGLAR ALARM SPRING.

The glowing of a lamp is an instant detector of such trouble, which heretofore has only become known by ordinary relay tests.

In the diagram, Fig. 2, we are allowed to show a new No. 2 quadruplex relay which is being patented by Mr. Jones, and which we saw working very satisfactorily on a New York and Chicago quadruplex circuit. The relay has had its magnetic strength increased by the introduction of an auxiliary main line magnet without increasing the inertia of the relay over that of the style of relay heretofore in use. The electro-magnetic induction coil has its secondary wire connected to an electro-magnet acting upon an armature and lever at right angles, and rigidly attached, to the ordinary vertical lever, so that the momentary pull of the magnet in the secondary circuits acts in the same direction as the pull of the main line magnets.

The key system shown in the diagram will be seen to have some merits not obtained in previous plans. There are no leaks nor resistances necessary to decide the strengths of currents for operation of the distant relays, and the failure of one or both dynamos on one side does not hinder the operation of the other side. To Mr Jones is also due the credit of this system, as evidenced by his patents of April, 1888.

The wiring, a task of no ordinary difficulty, has been admirably done by Mr. Gref under the direction of Mr. Minor M. Davis, whose intelligent assistance to Mr. Jones in the arrangement of the multitude of intricate details has tended largely to the complete success of the undertaking. Mr. Samuel Cowan has contributed efficient services in the matter of placing the engines, shafting, etc. Mr. Joseph Flood has been placed in charge of the dynamo and electric light plant, the operating room being managed by Mr. C. P. Flood.

A 10 h. p. electric motor will shortly be placed in position alongside of the steam engines as a factor of safety. The motor will probably be connected to the Edison distributing mains from the Edison Pearl street station. It is proposed to have the speed of the dynamo and the size of its pulley so arranged as to admit of one of the engine belts being shifted from the engine to the motor, connecting it up directly with the shafting that drives the dynamos. The steam now used is furnished at a pressure of 80 pounds by the New York Steam Company. Connections are already made with the company's boilers, which are held in reserve in the basement, at the rear of the present installation. Hence every precaution within human foresight has been taken to secure absolute continuity of operation.

### The Sperry "Double Induction" Motor.

Our illustration represents the Sperry "double induction" motor just brought out by the Electrical Supply Company, of Chicago. In this machine the armature, consisting of a ring wound with sections of wire, is stationary, and within it revolves the field magnet mounted on the shaft. The current in the revolving field magnet is continuous in one direction, but the armature wires are energized in succession so as to set up a continuous attraction for the field magnet.

These motors are manufactured ready for connection with the machine to be driven by a belt, and are built to be operated in connection with any source of electricity from a battery or from an arc or incandescent circuit of any system. When operating in connection with the arc system an automatic cut-out is attached to the motor.

A special form of battery has also been designed for use in connection with the motor for small powers, which is shown in the illustration, and which is said to have a very low internal resistance.

### Burglar Alarm Window Spring.

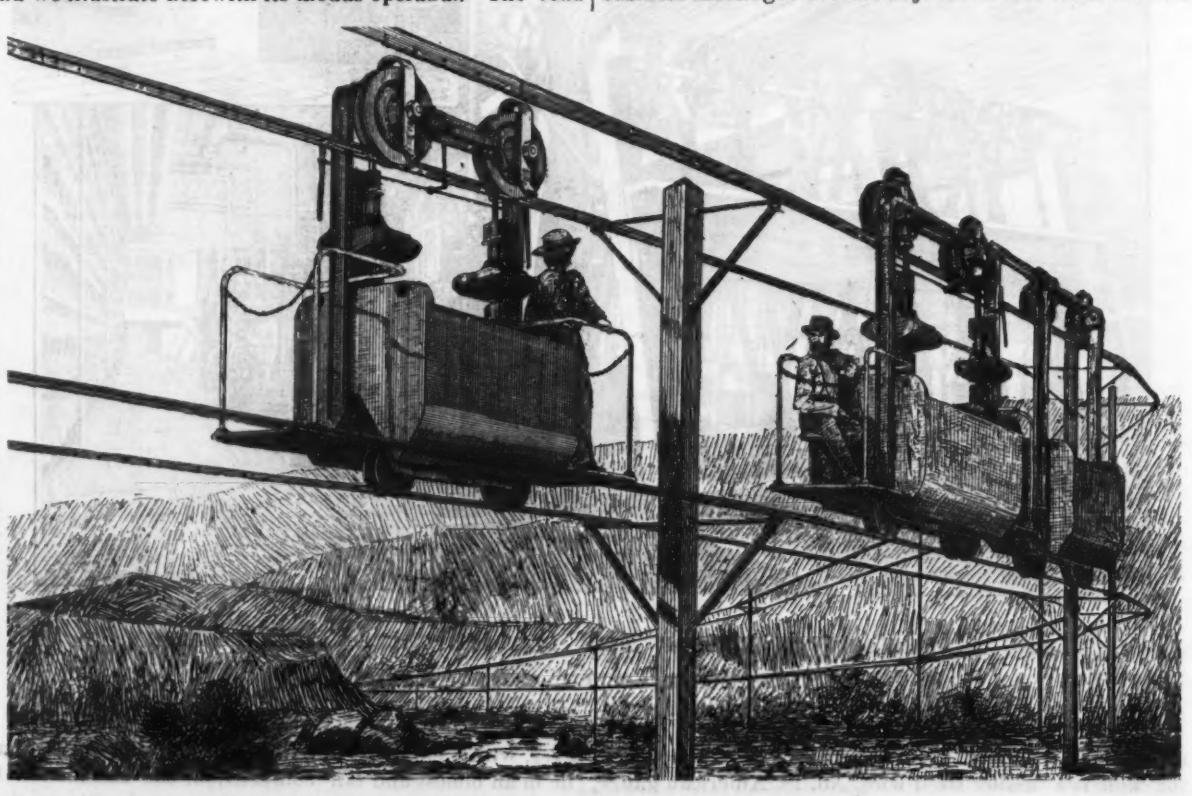
The difficulty experienced with many springs of the above nature is that they are continually getting out of order from the following causes: The contact springs catch in the weights or bind so closely in the grooves that it requires much force to raise or lower the sash; the brass springs and the wooden insulation are affected injuriously by the atmosphere and become brittle and break off; the spring becomes set from continuous use, and causes either false alarms by the shaking of the sash, or fails to give warning when necessary. In the form of window spring here shown the troubles above mentioned do not exist. The frame is made of hard brass $4\frac{3}{16}$ inches long, $\frac{3}{8}$ wide and $\frac{1}{8}$ deep. The openings for the screws for securing to the window frame are on the extreme end, permitting a solid foundation should a mistake be made in cutting the slot too long. The two springs acting on the tongue are made of the best German silver, their movement being so slight as to prevent a possible set or breakage. The lower spring is attached directly to the frame.

The upper one is insulated from it with hard rubber, both springs being securely fastened by machine screws from either side. In raising or lowering the window sash, the brass tongue is slightly pressed back, causing the upper spring to slide from the insulation upon the metal making a positive rubbing contact. The spring can be used on either open or closed circuit. It is made by Shaw & Geary, of Philadelphia.

THE SPERRY "DOUBLE INDUCTION" MOTOR.

### Telpherage for Mines.

The Sprague Electric Railway and Motor Company is now introducing a system of telpherage for mining work, and we illustrate herewith its modus operandi. The road or overhead track consists of two stationary steel cables suspended one above the other between posts of wood or metal, fifty feet and upward apart, and at such an elevation from the ground as not to interfere with surface traffic. The cars run on wheels and are suspended between the upper and lower cables, the upper cable carrying most of the weight. The upper cable is charged with a positive, and the lower with a negative, current of electricity. By contact of the wheels with the cables the current is conveyed to an electric motor in the car, which imparts motion to the wheel by gears, etc. These cars can be of any pattern, dimensions or material required by the service. They can be run at a rate of from four to twenty miles an hour. Such a system is simple and practical. It is economical to build, operate and maintain. It is above mud and floods; can cross streams, canons or marshes without bridges, and the cables are not affected by rain, snow or ice. Its adaptation to mining work is such that its use in many localities would cause a large reduction in working expenses, and often make the difference between success and the want of it.



THE SPRAGUE TELPHERAGE LINE.

### Electric Hoists for Mine Inclines.

One of the large incline hoists, operated by Sprague electric motors, two of which were built by the Sprague Company for the Roaring Fork Electric Light and Power Company, of Aspen, Colorado, for use in the mines there, has been put into successful operation the past week. This hoist is used for hauling empty cars into the "Veteran" tunnel. The loaded cars run out by gravity. The motor pulls the empty cars into the tunnel in trains of six each, at the rate of 500 feet per minute and with perfect ease. The distance is 1,000 feet, the grade 3 per cent. and the weight of a train 45,000 pounds. As soon as the incline can be timbered, the other hoist will begin its service.

### A Novel Porous Cup.

It is well known that considerable difficulty and expense accompanies the use of porous cups for battery purposes. The trouble lies principally in the fact that the cups are too porous and allow the fluids to pass through too easily. When the battery is not working, the acids pass from the inside of the cup to the outside, and, attacking the zinc, cause waste. The cup itself also soon becomes brittle and wears out. In fact, the materials, generally of the battery, are exhausted very rapidly on account of the too great porosity of the cup.

According to a recent invention of Messrs. B. J. & J. W. Wheelock, of this city, the cups may be brought to any desired degree of porosity. Their process of treatment consists in first heating the cup to about 110° F., and then applying paraffine to the surface of the cup. The heat will thus melt the paraffine, and allow it to penetrate its pores. These operations are repeated as many times as is necessary to bring the cup to the proper degree of porosity for the work which it is to be put to.

### The Telegraph Reunion.

The eighth reunion of Old Timers and of the U. S Military Telegraph Corps takes place next week at Chicago. Mr. W. J. Dealy, the secretary of the Old Timers, and Mr. James E. Pettitt, the secretary of the Corps, have issued a notice as follows:

The business meetings of the U. S. Military Telegraph Corps and of the Old Time Telegraphers' Association will be held in the parlors of Gore's Hotel, Aug. 15. The meeting of the Military Society will be held at 10 A. M. The meeting of the Old Timers will be held at 2 P. M. If the business meetings have not adjourned over from the 15th, the Committee on Arrangements will escort us to various places of interest until time for the starting of the magnificent steamer "John A. Dix" for an excursion on Lake Michigan. The dinner at Kinsley's will be served at 8 P. M. and will be within the means of all. Its cost per member is indeterminate at this time and will depend largely upon the number of plates to be set. It is to be hoped that every member will make an effort to be present at this reunion. Please notify A. H. Bliss, chairman Committee on Arrangements, Room 14, Imperial Building, Chicago, as early as possible, whether you will be at the meeting.

### The Thomson-Houston Electric Road at Crescent Beach, Mass.

The accompanying cut, Fig. 1, shows the style of car in use on the electric railway at Crescent Beach, Mass. These cars are equipped with the Thomson-Houston motor, which has proved itself to be especially adapted to this class of work.

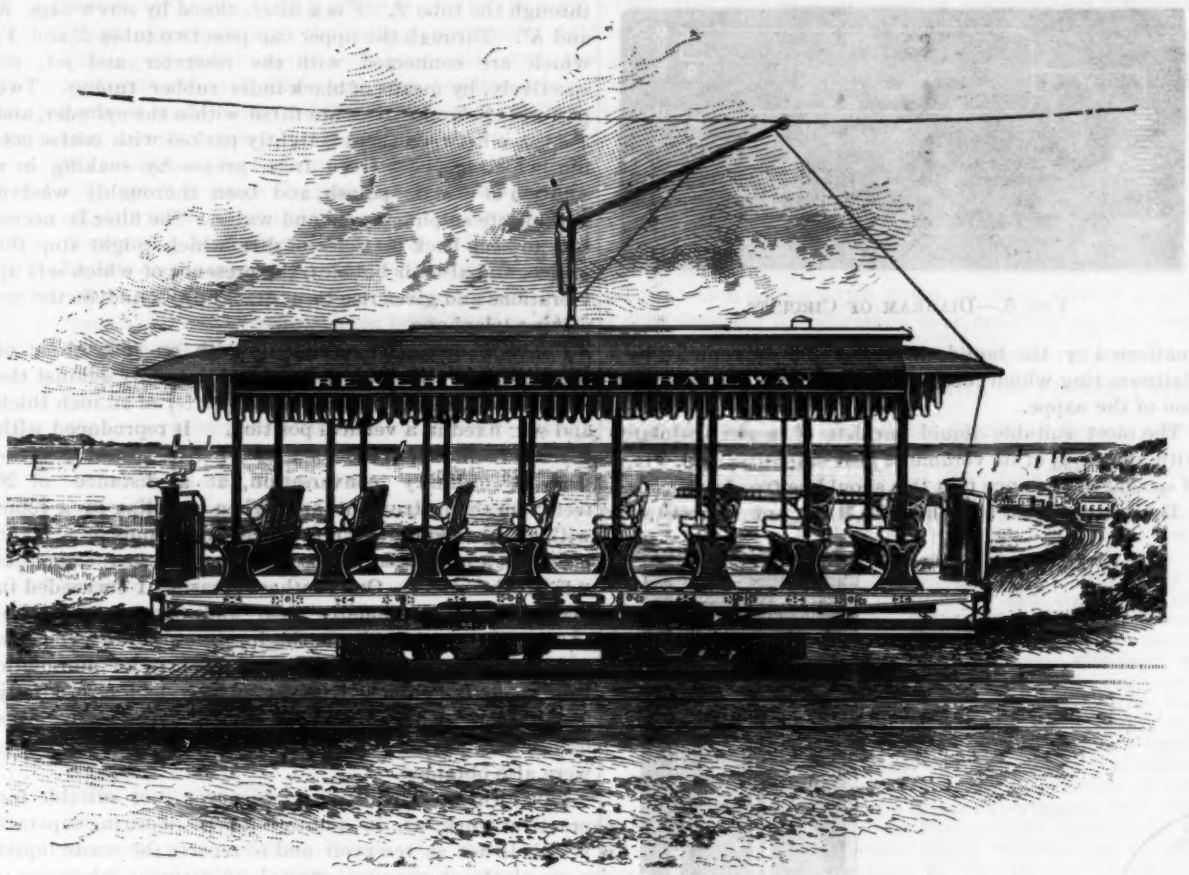



FIG. 1.—THOMSON-HOUSTON CAR AT CRESCENT BEACH, MASS.

The road was inspected last week by a large party of capitalists and electricians who are specially interested in the now rapidly developing department of electric railways. An explanation of the system was given by Mr. G. W. Mansfield, and three cars were handled in various ways to show the convenience and flexibility of the system.

In order to utilize the electrical transmission of power to the fullest extent and to advantage, it is necessary to have a motor which shall combine the highest electrical efficiency with the greatest mechanical perfection. The motor manufactured by the Thomson- Houston Company was designed to meet these requirements. It is capable of being applied to every condition in which power can be used, without any of the inconviences attendant upon the use of isolated steam plants or the use of gas or petroleum engines. The regulation of the motor is practically perfect, a variation of less than 2 per cent. in speed being observable in change from full to light load; and at the same time there is no sparking at the commutator, nor is it necessary to change the position of the brushes under any change of the load. This automatic action removes the necessity of constant attention. Fig. 2 shows the new modified type.

### Circular Mils Defined.

*To the Editor of The Electrical World:*

SIR: In a recent issue of your valuable paper there appeared an article entitled "A Table for Incandescent Lamp Leads," with formula and table attached. Please give me, through the columns of your paper, a definition of circular mil and its relation to a decimal of an inch, as the wire and resistance table I have gives equivalents in decimals of an inch, but not in circular mils. Further, I do not comprehend why the article is headed "A Table for Incandescent Lamp Leads," because it can be applied everywhere where current, distance, and drop are factors in the size of wire required.

PAUL W. KNAUF.

ANSWER.—The "circular mil" is an arbitrary unit devised for the purpose of comparing the relative cross-sectional areas of wires directly, without resorting to the work squaring their diameters. The circular mils of any wire is the diameter in thousandths of an inch squared. Thus a No. 4 B. & S. wire, which has a diameter of $\frac{204.31}{1000}$ of an inch is said to have an area of $204.31 \times 204.31 = 41.742$ circular mils. In the same way a conductor one inch in diameter has an area of $1,000 \times 1,000 = 1,000,000$ circular mils. Hence, bearing in mind that 1,000,000 circular mils represents an area equal to .7854 square inch (the area of a circle one inch in diameter), we have the direct relation between circular mils and the decimal of a square inch. As you remark, there is no reason for confining the table to incandescent lamp leads, but it may be applied to any other class of electric distribution.—EDS. E. W.

### Novel Construction of Secondary Batteries.

The aim of most constructions of secondary batteries has been to keep the active substance of the electrodes as porous as possible. The method pursued by Mr. E. E. Vaughton, of Birmingham, Eng., as described in a recent English patent, is the reverse, for by the continued exertion of evenly distributed pressure upon the surfaces of the electrodes, the active material is rendered as compact as possible, and is kept in perfect electrical contact with its support. The light plates of lead forming the electrodes may be either in the form of plain sheets or with single or double flanges, and may be perforated or not. The active material is red lead, which is applied to the supporting plate in a plastic state in a layer of a thickness equal to the depth of the flanges. When this active matter has been subjected to a uniform pressure for some time, it is found to assume the hardness of terra cotta, and it can then only be removed by chipping, and the longer the accumulator is used the tougher becomes the active material. Each active surface of the electrode is covered with canvas, and between each two pieces of canvas is placed a layer of non conducting porous material, such as asbestos. Between such partitions are driven several pairs of wedges, so as to exert the necessary pressure.

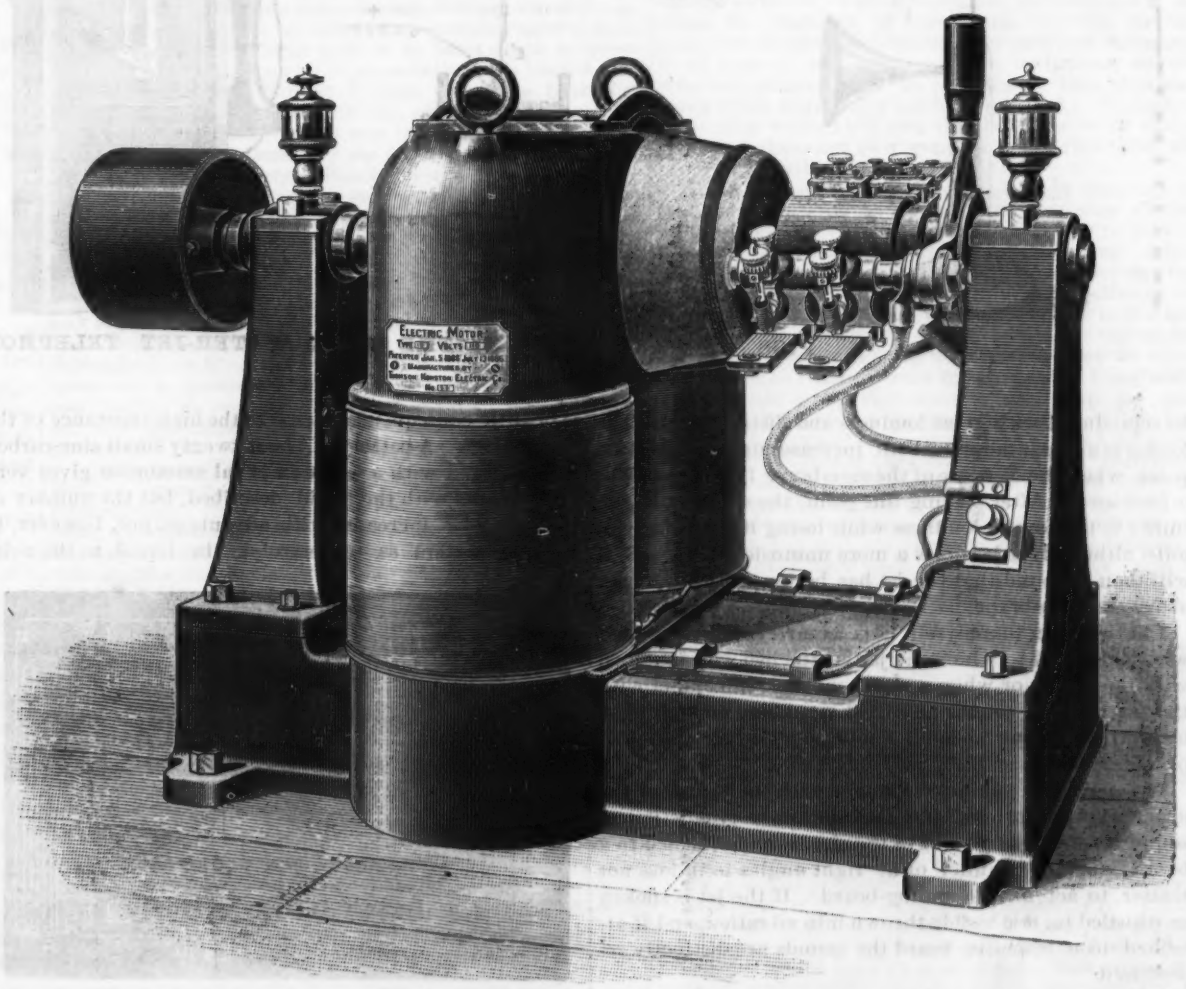



FIG. 2.—MODIFIED THOMSON MOTOR.

### The Electric Resistance of Copper at Low Temperatures.

A further contribution to this subject has just been made by M. Wroblewski, who undertook to test the truth of Clausius' remark in 1856 that the electric resistance of chemically pure metals should be proportional to their absolute temperature. M. Wroblewski took advantage of one of the new methods of producing intense cold, namely, that by means of boiling nitrogen at the temperature of its solidification. The results are embodied in the following table, where $t$ is the temperature, $r$ the resistance in Siemens units, and $a$ the coefficient of variation of resistance between two consecutive temperatures:

| BOBBIN I. | | | BOBBIN II. | | |
|---|---|---|---|---|---|
| $t$. Deg. C. | $r$. | $a$. | $t$. Deg. C. | $r$. | $a$. |
| — 100 | 5.174 | ..... | + 23.75 | 19.251 | ..... |
| — 21.4 | 3.934 | 0.004365 | ± 23.75 | 17.559 | 0.004057 |
| ± 21.4 | 3.614 | 0.004136 | — 103 | 9.848 | 0.004263 |
| — 103 | 2.073 | 0.00414 | — 146 | 6.749 | 0.004104 |
| — 146 | 1.360 | 0.004588 | — 193 | 2.731 | 0 004869 |
| — 193 | 0.580 | 0 004592 | — 201 | 1.651 | 0.007688 |
| — 200 | 0.414 | 0.006562 | | | |

These numbers seem to show that the resistance decreases much more quickly than the absolute temperature of the specimens, and approaches nil at a temperature not very far from that obtained by evaporating liquid nitrogen in a vacuum.

### A Novel Coulomb Meter.

M. Marcel Deprez has devised an instrument for giving at will an invariable quantity of electricity—for example the coulomb. It consists of a glass tube of U-shape, having its two legs closed and terminated by glass bulbs of much larger volume than the cylindrical parts. One ball and its corresponding leg is filled with water acidulated with sulphuric acid. The second leg contains also some liquid below, but for most of its length it and the ball ending it is filled with air at a fixed pressure. The branch filled with liquid has four electrodes face to face in pairs, two at the upper part of the ball and two in the cylindrical part a little below the lowest point of the ball. If an electric current is sent through these last, the water is decomposed and the mixture resulting from the decomposition accumulates in the upper part of the ball, whilst the liquid is forced up the second branch, compressing the air in it. If the point of departure of the liquid column in the second branch is noted as well as the point it stops at when the current is stopped, all the elements necessary to know the quantity of electricity expended to produce the mixture of gases are forthcoming, and it is easy to see that if the volume of this mixture, measured by the ascension of the liquid in the second branch, is always the same, the quantity of electricity necessary to produce it will be equally invariable whatever be the temperature of the instrument, provided it be the same in both branches, a condition easy to realize. The barometric pressure and

hygrometric state of the air have evidently no influence on the results, since the tube is sealed like an incandescent lamp. In short the apparatus produces at will a quantity of gas corresponding to the invariable quantity of electricity taken for standard, all the operation being the observation of the scale on the branch of the tube, and there being no correction to make. In order that the apparatus may continue to act indefinitely, the water is reformed at each operation by a spark passed through the detonating mixture of gases in the ball. For this purpose the other pair of platinum wires is provided. The instrument may serve for the standardizing of electric measuring instruments. It has been tested with great care by M. Minet, one of the engineers of the Creil experiments, and its indications compared with the ordinary voltameter, and found to be fully reliable.

## C. A. Bell's Water-Jet Telephone Transmitter and System of Telephonic Communication.

BY G. W. DE TUNZELMANN, B. SC.

In May, 1886, Mr. Chichester A. Bell, M. B., read a paper at the Royal Society on the sympathetic vibrations of jets, and it is on some observations recorded in this paper that the water-jet transmitter is founded. When a jet of water issues from a narrow orifice it gradually becomes discontinuous and breaks up into drops as shown in Fig. 1, which is taken from an instantaneous photograph. Fig. 2 shows a jet of water from a tube fixed to a board, falling on a membrane of stretched india rubber, forming a cap to a brass tube which can be raised or lowered by sliding in a larger tube resting on a heavy stand. The upper tube has an orifice at one side of the upper end, to which is attached a vulcanite trumpet.

Mr. Bell found that with this apparatus, either mechanical or sound vibrations, communicated to the jet could be reproduced with great loudness and distinctness. The loudness and distinctness both increase up to a certain point, when the distance of the membrane from the orifice is increased. After passing this point, the sound still continues to increase in loudness while losing its distinctness, until ultimately it becomes a mere unmusical roar, and it will then be found that the jet has become discontinuous above the membrane.

I have shown this myself as a lecture experiment, and when the board to which the jet is attached was scratched with the finger, or when a watch was held in contact with the jet tube, the sounds produced were loud enough to be heard throughout a room containing several hundred people.

The jet need not be in contact with the board for the latter experiment, but for the audible reproduction of sound it is necessary to have the jet rigidly attached to a board, whether parallel or at right angles to it does not matter, to act as a sounding-board If the jet is spoken or whistled to, it is visibly thrown into vibration, and if attached to a sounding-board the sounds are distinctly reproduced.

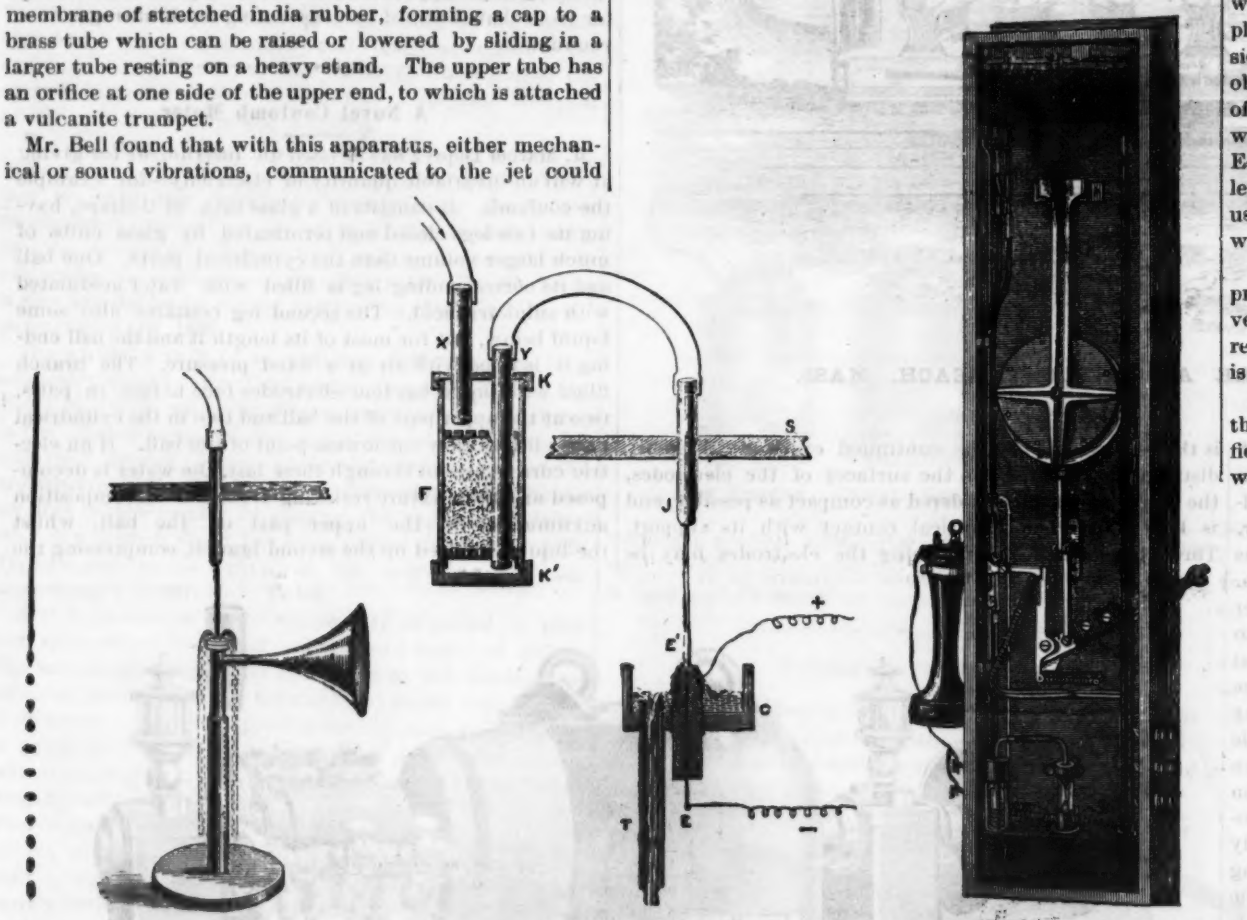
If the jet is allowed to fall upon a narrow vertical rod it spreads out into a nappe, and Mr. Bell found that this nappe was capable of responding to vibrations in a similar way to the jet itself, and it is this property which is utilized in the construction of the water jet transmitter.

The principle of this instrument consists in including the nappe of a jet of conducting liquid in a circuit traversed by a current from a battery, and containing an ordinary telephone. The nappe formed by the impact of a steady jet retains a constant diameter, but when thrown into vibration it undergoes periodic changes in diameter, and, therefore, also in resistance, which Mr. Bell considers to be due in part to the changes in diameter, and in part to changes in the contact resistance arising from the motions of the particles of liquid; so that the current passing through the circuit undergoes corresponding continuous vibrations in strength, as in other forms of telephonic transmitters. The simplest way of passing a current through it consists in allowing the jet to strike normally upon the exposed end of a platinum wire embedded in an insulator which is impervious to, and is unaffected by, the liquid employed, and surrounded by a platinum ring which comes in contact with the outer portion of the nappe.

FIG. 6.—DIAGRAM OF CIRCUITS.

The most suitable liquid consists of water acidulated with about $\frac{1}{100}$ of its volume of pure sulphuric acid. It is of special importance that this should be free from lead.

The battery must be of high E. M. F., but its resistance is of little consequence, owing to the high resistance of the transmitter. A battery of about twenty small zinc-carbon cells charged with a solution of sal ammoniac gives very good results with the liquid described, but the number of cells may be increased with advantage, not, however, to such an extent as to electrolyze the liquid, as the noise produced in the receiving telephone by the escape of gas bubbles would drown the sounds due to vibratory changes in the jet. The pressure required increases with the size of the jet, and with jets of the most suitable size, a pressure of a little under three feet of water gives the best results.




FIGS. 1, 2, 3, 4 AND 5.—THE BELL WATER-JET TELEPHONE TRANSMITTER.

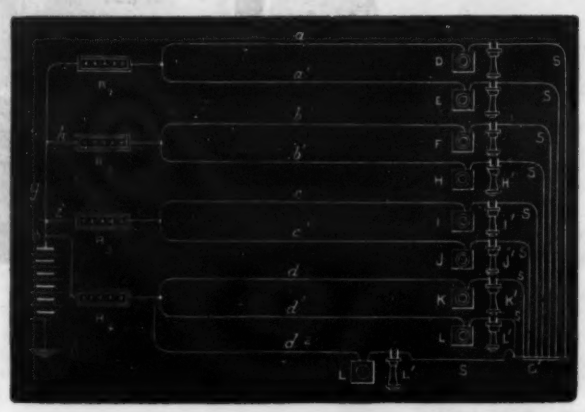


FIG. 7.—DIAGRAM OF CIRCUITS.

A simple experimental form of apparatus is shown in Fig. 3. The jet tube *J* is mounted on the sound board *S*. The receiving surface is formed by the end *E'* of an ebonite plug. A platinum wire *E* passes water-tight up the plug, and its upper exposed surface forms the inner electrode of the transmitter. The outer electrode *E'* consists of a small tube of platinum foil concentric with the upper extremity of the wire *E*, and is insulated from it by the ebonite. After it has been fitted on, the top of the ebonite plug is turned off so as to present a smooth, continuous surface, slightly convex. Fine platinum wires welded to *E* and *E'* serve to connect them with the terminals of the circuit. *C* is an ebonite cup, which supports the plug and receives the waste water which escapes through the tube *T*. *F* is a filter, closed by screw caps *K* and *K'*. Through the upper cap pass two tubes *X* and *Y*, which are connected with the reservoir and jet, respectively, by means of black india rubber tubing. Two perforated ebonite discs are fitted within the cylinder, and the space between them is tightly packed with coarse cotton, which has been freed from grease by soaking in a solution of caustic potash, and been thoroughly washed with dilute sulphuric acid and water. The filter is necessary to keep back particles of dirt which might stop the orifice, and also air bubbles, the presence of which sets up vibrations and gives rise to a crackling sound in the receiving telephone.

I have made some experiments with an instrument of this kind, but with the jet pressed laterally against the sound-board, which was about a quarter of an inch thick and was fixed in a vertical position. It reproduced with perfect distinctness the voice of a person speaking in the tone of ordinary conversation, at a distance of 20 feet from the instrument, and when standing in a room with an open window it reproduced the sounds of a piano played in a room also with a window open, at the opposite side of the street. On another occasion I succeeded in obtaining an exceptionally clear and pure reproduction of the voices of four boys singing in unison in a room in which the transmitter was placed. When an automatic Edison chalk-cylinder receiver, which had been kindly lent to me by the United Telephone Company, was used in place of an ordinary Bell telephone, good results were also obtained.

This form of apparatus is, however, not suitable for practical work, as, in addition to its requiring separate vessels to act as reservoir and to receive the waste liquid respectively, it requires careful adjustment whenever it is to be used.

A great many forms of apparatus have been devised for this purpose, and some of them are described in the specification of the patent which was taken out in 1886, and which covers the whole principle of the apparatus. It has been acquired, as far as the American rights are concerned, by the American Bell Telephone Company. It is only quite recently, however, that the inventor has succeeded in devising an apparatus which combines simplicity and certainty of action with durability.

Fig. 4 shows the instrument with front removed, and Fig. 5 shows the transmitter and filter on an enlarged scale.

The whole apparatus is inclosed in a case of teak or mahogany about 3 feet high, and is protected in front by a cover which opens on hinges, and is provided with a lock and key.

There is a round aperture, protected by crossed copper wires, opposite the transmitting jet, and in using the instrument the mouth of the speaker is placed at a distance of a few inches from this aperture, as it is neither requisite nor desirable to have a jet as sensitive as that of the experimental apparatus previously described.

The electrodes in this instrument are formed of a platinum wire passing up the centre of a glass plug and a concentric ring of fine platinum wire, glass being used instead of ebonite on account of its being found more durable. The jet and plug are contained in a glass tube attached to a wooden box resting on the bottom of the case, which receives the waste liquid. The glass plug is rigidly fixed in a vertical position, and the jet is centrally adjusted over it by means of the four screws shown at the upper end of the containing tube. The filter is seen on the left hand side of the jet; its exit tube has its extremity enlarged into a bell which contains the cotton, and the fibres of this are protected from passing into the narrow part of the tube by means of a piece of cotton material, placed at the top of the bell. The reservoir consists of a second box, similar to the first, placed at the top of the instrument, and is filled by taking out a screw plug in

the centre of its upper side, and pouring the liquid in through a funnel.

The terminals of the receiving telephone are connected with the two left-hand binding screws, the lower one of which is connected to one electrode of the transmitter, and the upper one to a pair of springs, which make contact with the lever from which the telephone is suspended when the latter is removed and the supporting hook allowed to rise. The other electrode is connected with the lowermost of the three binding screws on the right, which is put to earth through the battery; the central right-hand binding screw is in permanent connection with the lever supporting the telephone and with the line, while the uppermost one is connected through the call apparatus to the line, and also with a spring which makes contact with the telephone lever when the telephone is hung up.

To speak through the instrument the telephone is taken off, but the hook end of its supporting lever is prevented from rising, by means of the vertical lever shown. The handle on the right-hand side of the case is now depressed, when a pin on its lower end draws back the vertical lever and allows the telephone hook to rise, placing the telephone in circuit with the line.

The telephone lever in rising pushes up a brass rod hinged to it, thus lifting the left hand end of the lever above the reservoir, and opening a valve which allows the fluid in the reservoir to flow down an ebonite tube on the left-hand side into the filter. A second ebonite tube passes from the filter and opens into the top of the reservoir to allow air to escape immediately if the filter has run particularly dry from the instrument remaining unused for some time. The depression of the right hand lever at the same time compresses an india rubber bag shown in the centre of the case, and drives air into the lower box through an ebonite tube, seen on the right-hand, which is provided at its upper end with a valve opening inwards, and forces liquid from the lower reservoir through the other ebonite tube on the right-hand into the upper reservoir.

The amount of liquid pumped up by one depression of the lever is sufficient for about seven minutes' conversation, and as the average length of a conversation would usually be less than this there will usually be enough liquid in the upper reservoir to allow of a longer conversation, as often as it is likely to be wanted, without pumping up fresh fluid, which, however, does not interfere in any way with the conversation being carried on. The object of the control lever which keeps the telephone out of circuit until the right-hand lever is depressed, is to prevent users from forgetting to pump up a fresh supply each time.

The instrument is chiefly valuable for use on trunk lines over long distances, as any leakage on the line can be compensated by using additional battery power, and very good results have been obtained with it on lines upwards of 100 miles in length, and passing through six or eight exchanges, and, therefore, subject to a considerable amount of leakage. In general four Leclanché cells are sufficient.

The system of telephonic communication, devised by Mr. Bell, is intended specially for use with the water-jet, or any other form of high resistance transmitter, and its principal advantage is that it does not require the use of any batteries except at the exchange.

With the transmitter now in use it is not practicable in the case of lines of any length to transmit speech by the direct action of the vibration of the transmitter in varying the resistance of the line-circuit, and therefore an induction apparatus is used, the transmitter being placed in the primary and the line in the secondary circuit, and this involves the use of a battery at each sub-station.

Let us consider the arrangement shown in Fig. 6, which shows a battery $B$ of high E. M. F. and low resistance, put to earth at $G$ and connected with a line $d$, which divides into two branches $a$ and $a'$, which contain the transmitters $D$ and $E$ and the receivers $D'$ and $E'$, and are then put to earth at $G'$ through the wires $S\,S$. Vibrations communicated to either transmitter will not be communicated to the receiver at the other station, because the earth connection through the battery forms a low-resistance shunt. If, however, a suitable resistance $R$ is inserted in the branch $d$, as shown in Fig. 7, this will no longer be the case, and it is easy to make the resistance $R$ so large that practically the whole disturbance originated at $D$ is transmitted to $E'$, more cells being added to the battery if necessary. The inventor has found experimentally that in the case of short lines (such as ordinary town lines) the resistance $R$ may be varied from about 2,000 to 8,000 ohms without appreciably affecting the action of the transmitter, supposing the jet transmitter to be used, the resistance of which is about 1,000 ohms.

In practice it is desirable to make the resistance $R$ adadjustable, as it may then be varied as may be requisite to compensate for hygrometric variations in the resistance of the lines.

If the stations $D$ and $E$ were connected directly through a battery at the central station, a battery of twice the E M. F. would be required to give equally good results, as has been proved to be the case by experiment. Further, if the two stations are connected directly through the central battery, and the transmitters are of unequal resistance, the speaker at the low resistance end will not be heard so well as the one at the high resistance end, but this is not found to be the case when the connections are made as described.

A single battery can be used for all the subscribers to one exchange if desired.

Thus Fig. 7 shows two additional pairs of subscribers using the transmitters $F$ and $H$ and $I$ and $J$ connected through the resistances $R_2$ and $R_3$ and the wires $h$ and $i$ with the wire $g$ from the battery to $R_1$, and it is found that each pair can carry on conversation without interfering with, or being overheard, by any of the others.

Fig. 7 also shows a group of three transmitters connected through the lines $d$, $d_1$ and $d_2$, the resistance $R_4$ and the wire $j$, with the central battery. In this case a speaker at one transmitter, $K$ for example, will be heard in the receivers $L'$ $L'$ at both of the other two stations.

At an ordinary telephone exchange a battery with an E. M. F. of from 30 to 40 volts would be required, and it should have large plates. A battery of about 20 medium sized secondary cells answers admirably, but any battery which does not run down an open circuit may be used, provided its resistance does not exceed a few ohms.

## Physiological Tests with the Electric Currents.

At the invitation of Mr. Harold P. Brown, a large number of electricians assembled at Columbia College on Monday, July 30, as noted in these columns last week, in order to witness his experiments on the effects of the electric current on dogs. These experiments consisted first in passing a current through the dog from an Edison "municipal dynamo," which had been provided with a relay to prevent the extra current from reaching the animal upon the opening of the circuit. The resistance of the dog at the start was 15,300 ohms, and, beginning with 300 volts, the pressure was increased to 1,000 volts without fatal effects, although the dog suffered somewhat under the higher pressures. The alternating current was then tried, and on the first application with 330 volts the dog was killed, dying without a struggle. Mr. Brown had intended to make experiments with other dogs, but was prevented therefrom by an officer of the Society for the Prevention of Cruelty to Animals. Mr. Brown in his experiments was assisted by Mr. A. E. Kennelly, Dr. Peterson, Dr. Schuyler S. Wheeler, and Mr. T. Carpenter Smith volunteered to check the readings at the request of Mr. Brown. Coincident with his experiments, Mr. Brown read the following paper:

ON THE DANGER OF ALTERNATING CURRENTS.

GENTLEMEN: I appear before you in behalf of the many men who have met sudden and violent death from electric light machinery. Not only have they been robbed of life but their memory has been blackened by the accusation of foolhardy carelessness from the testimony of their employers and associates. I do not mean to say that none of these men have been responsible for the accidents that killed them, but I do say that in every case their employers have sought to evade responsibility by throwing the blame on the dead man who cannot defend himself; so, if these reports are to be believed, it is as disgraceful to be killed by electric currents as it is to meet death by blowing in the muzzle of a gun to see whether it is loaded. In the case of lineman Murray I quote from the *Herald* of May 12, in an interview with the superintendent: "He removed the insulation from one of the wires with something, probably his knife. I do not know why he did so, for it was not necessary. When he removed the insulation he cut into the wire, as is shown by the freshly cut copper, and then must have made a contact with the iron cornice and current passed through his system. His experience ought to have taught him the danger of what he was doing."

Murray might have taken hold of the bare wire without any injury had there been no other ground connection upon that circuit, or had the wire been perfectly insulated throughout its length; he had no means of knowing that there was a ground on the circuit, and it was the company's duty to see that the line was clear from grounds; he had no means of knowing that the cornice was grounded.

I quote from THE ELECTRICAL WORLD of July 28: "At Halifax, some time ago, a lamp trimmer climbed a pole to trim a lamp. The current, it seems, was on. By carelessness, we will assume, he took hold of both wires and was instantly killed. The next day, or day after, a second man was in like manner killed. They thought they knew all about it. It is said, and, if it is true, to be unconditionally condemned, that the electric light company are running some 90 lamps and about 4,000 volts on this circuit, by reason of which they save the wire necessary to divide the lighting into two circuits. Such economy is criminal in the extreme."

Of course these deaths are assumed to be from carelessness because the "company" says so. But the last sentences quoted show that the poor fellows were in no way to be blamed. In any case if it is necessary to carbon the lamps when the current is on, it is the company's duty to supply each lamp with a switch that will cut the lamp entirely out of the circuit.

On May 6, 1887, Mr. J. T. Simpson, engineer in the Adams Express Building, was killed by putting his hand on the circuit while standing on the floor. A week or so ago another engineer was killed at the same place and in the same manner, and I do not suppose that the company which installed that plant has even yet seen fit to notify its owners that their circuit is probably grounded.

But it is unnecessary to multiply cases, as the press has been led to believe from statements of superintendents and managers of electric lighting companies that death from electricity is necessarily from carelessness. For a long time I have felt that it was my duty to tell the truth, in the hopes that it would lead to the adoption of safety devices, and as case after case was published I have felt guilty because I had not the courage to do so. Finally, when young Streiffer was killed on April 15, by touching a straggling telegraph wire, and the following day two telephone wires dropped in the street in front of my house, I could keep silence no longer, and I wrote an article calling attention to the causes of death from electric lighting; and suggesting means for rendering fatal accidents less frequent.

In the course of this article I could not refrain from stating what I thought of the system of operating incandescent lights in our homes by means of alternating currents, since I had good reasons for believing these currents far more dangerous than those for operating arc lights in the streets and in stores, where the wires are ordinarily out of our reach. I knew that the letter would cause a terrible outburst of indignation against me on the part of the wealthy and powerful "combine" of corporations which is exploiting the alternating system, but I believed that I was right, and therefore had the courage to state what I considered to be facts.

Having written the letter and submitted it to several friends for criticism, I tried to get it published, never anticipating any difficulty in that respect, since its object was public safety. I left it with the assistant city editor of a prominent morning paper, and he seemed very glad to get it. After waiting for a while I called upon him and he said he was very sorry, but the fact was that he could not use the article.

Warned by this I obtained letters of introduction to the manager of another prominent morning paper and stated the case to him. He agreed at once to publish it. I waited for some time and then sent a friend who was well acquainted with an assistant editor to ask after it. The reply was that if the part of the article referring to alternating currents was omitted it would be acceptable; if I insisted upon having it published as it was, it should go in, but he would advise me not to do this.

By this time two more deaths had occurred and I rewrote the article and took it to the editor of the *Evening Post*, who kindly published it. It was my intention to demonstrate with arc lighting machinery the exact truth of my statements and the value of my suggestions, and this I shall do on a future occasion. But a few days after my letter was published an anonymous correspondent attacked me in a letter to the *Post*, written in the interest of the alternating current system.

On June 8, at a meeting of the Board of Electrical Control, Commissioner Daniel L. Gibbens read my article and offered a resolution, which was adopted, that it be published in the minutes and a marked copy sent to various electric lighting companies and others, asking their opinion in writing or their appearance before the Board to discuss the matter. This meeting of the Board was deferred until July 16, and I was in Virginia on that date. I wrote that I was unable to attend, but would invite the Board and those interested to meet me at a later date.

At this meeting many letters were read. Those from Mr. Ralph W. Pope and Prof. Henry Morton were written in a scientific spirit and were dignified and gentlemanly, as would be expected from men of their standing. But all the other letters were from persons in the employ of the alternating systems and were bitter, personal attacks upon me, instead of scientific discussions of the subject. The alternating combination had evidently directed its men to crush this poor egg shell who objected to alternating currents, strip him of all reputation for honesty and decency and ruin him as an example to all who have the temerity to oppose them.

After these attacks, to which I will refer in detail later, there remained but one thing for me to do to clear myself; I must show from their own current and its effect upon life as compared with continuous currents, that my statements are true. Words are of no avail against such accusations as theirs. I therefore made preparations to demonstrate the character of alternating currents so that they could no longer claim them to be safe and harmless, and, in all honesty and fairness, sent invitations to the men who had attacked me to be present this afternoon and learn what alternating currents could do. I blush for my profession when I tell you the next move of the opposition, and there are two gentlemen in this room who can prove the truth of my statement.

Having done all they could to publicly blast my reputation and stamp me as an ignorant impostor in electrical engineering, they tried to invoke the law to prevent my disproving their charges by a demonstration. After trying to rob me of my means of obtaining a living, for I am not in the employ of any company, corporation or individual, they proposed to gag me by appealing to the law.

In spite of this affront I shall invite the representatives of the alternating current who are present to appoint a committee of three to come forward when I deal with their current, test all my connections, check up my measurements with their own instruments and see that I am not deceiving in any of my experiments But I do this upon the condition that if they make a counter demonstration they will afford me the same privilege, and give me the same notice that I gave to them.

I do not propose to present a scientific paper to you this afternoon, but will simply give you a few samples of the experiments I have been engaged in for a considerable time, in order to determine the death points of continuous, pulsating and alternating currents, and will reserve the full report of the same and the conclusions to be drawn from them for the subject matter of another paper. Dr. Frederick Peterson, who has had many years experience in diseases of the nerves, has assisted me by dissecting some of our subjects and making microscopical examinations. He will do the same this afternoon, if any of our experiments with the alternating or continuous currents have a fatal ending, and will read to you a brief paper on the subject.

I have invited the representatives of the press as a means of affording protection to the public, since the alternating current people claim their system is perfectly safe, and if it is not so the public should be warned of it so that they can be on their guard when they encounter it. I hold that all currents with an electromotive force (or pressure) of 500 volts or more, are dangerous to life and should be surrounded with all possible precautions; that apparatus can be made which will render both the continuous and pulsating currents safe in ordinary use; that apparatus has not yet been invented that will make alternating currents equally safe.

Therefore if the press and the public understand the conditions and insist that the pressure of the alternating current be reduced to safe limits until some safety device is invented for higher pressures, it will not be long before some such invention is forthcoming. Not many years ago the sudden growth of the telephone business and the great number of wires over buildings and on poles, led the press to demand that they should be placed underground. At once all the telephone experts protested that it was impossible; telegraph wires could go underground, but not telephone wires. The press hammered away on the subject, and, as a result, many cities prohibited the extension

of pole lines. Then the telephone men discovered means of operating their wires underground, and such lines appear to give better results than the old ones.

It was the same with the underground electric light wires. All of the experts protested not long ago that it could not be done; if it was insisted upon they would all have to go out of business and their investments would be worthless. Mainly through the insistence of the press some cities would permit no electric light lines on poles. In these places the wires went under ground, and are working with apparent success. It is simply a matter of the amount of money expended upon insulation and the care with which the water is kept out of the joints.

Now, if I can convince the Board of Electrical Control and the press representatives that the alternating currents as at present used are a constant menace to life and limb, I am sure that some safe way of electric distribution will be promptly devised, and these companies will not go out of business. The alternating current combination is an immense one, and has unlimited capital at its disposal; it can well afford to expend a fortune, if necessary, in experimenting upon safety devices, but it will not do so unless it is forced to it.

What corporation ever has spent money for the safety of the public until it was forced to do so by legal enactments or by business competition. The greatest life-saving invention of modern times, the air-brake, was not adopted voluntarily by the railroads. For years many of their managers insisted that no mechanism could be as reliable as a brakeman with his hand-brake. At last they were all forced to yield and the saving of lives and money through the use of the air-brake cannot be computed.

The friends of the alternating current system have tried to give the impression that I am the only person who is in favor of limiting their voltage, excepting, of course, their competitors in business. That is a very broad statement, and I will reply by quoting from the English law on the subject.

"§ 19. The electricity passing at any time through any electric line of the undertakers, being in or under the premises of any consumer, shall not exceed 200 volts for incandescent lighting, nor 4,000 volts for lighting by the arc system or for the transmission of power."

In regard to Germany, I quote from a letter to a prominent insurance man, from a member of the firm of which Siemens Brothers are the head:

"DEAR SIR: Replying to yours of the 24th inst., I beg to state that as far as I am aware there are at present no high tension converter installations in use in Germany; as to England I am unable to speak. Speaking for myself personally, I am decidedly of the opinion that in Germany the converters would not be permitted inside of the buildings, and further, in my opinion, even the secondary wires would be looked upon with suspicion, wherever the converter itself might be placed, in view of the great liability of the high-tension current to escape to and traverse them. Yours very truly,

E. KAISER.

The recent French electric lighting act is even more severe. I have not yet received a full copy of the new law, but quote from the London *Telegraph Journal and Electrical Review* of July 6, 1888: "It would appear that so long as a certain voltage (60 volts for alternating and 500 volts for continuous currents is not exceeded, but little control is exerted over complete installations carried out on one and the same premises, the preliminary formalities, in these cases, being dispensed with. The safety of the workmen is particularly cared for, it being enacted that they are to wear India rubber gloves, and on no account to carry bare wires in their hands." These limits were set in accordance with the recommendations of M. d'Arsonval, who has made a study of the danger limit and who was the first to suggest the placing of a voltameter across the terminals of a continuous current dynamo, as a means of protection against the extra current caused by opening the circuit. This gentleman says that one-sixteenth of the pressure used and declared "safe" by the alternating current people in this country, is fatal. We will try to find out this afternoon which of the two is correct.

For the benefit of those who are unfamiliar with electrical units, I will say that the volt is the unit of electromotive force (or pressure), and the ampère is the unit of current strength, and the ohm the unit of resistance. Currents which flow steadily in one direction are called continuous, and those which have an impulse first in one direction and then in the other, are called alternating.

My first experiment will be with the continuous current, and I have arranged a relay so as to prevent the extra current, caused by opening the circuit, from reaching the subject. I have asked Mr. A. E. Kennelly, chief electrician of Mr. Edison's private laboratory, to assist me in the management of the current strengths and the reading of the voltmeters, and I would like to have Mr. Schuyler S. Wheeler, electrician of the Board of Electrical Control, to superintend the measurements of the resistances of the subjects, and if Prof. Henry Morton is present, would be very glad to have him assist in the same and check readings on any of the instruments.

The resistance of a living being will be found rather troublesome to measure, as even the small current used for the purpose will, as soon as it passes through the living tissue, tend to reduce the resistance, especially so if it be alternated. This is one reason why alternating currents are more dangerous, since the longer they flow, the less the resistance becomes, and the greater is the amount of current received. The tension of the muscles will also still further reduce the resistance.

I have in the engine room a dynamo made by the Edison Company for municipal lighting, and I have arranged these resistance boxes in its field (or charging magnet) circuit so that I can vary the pressure at will from zero to 1,400 or 1,500 volts. I propose to close the circuit upon the subject at gradually increased pressures, and as long as the relay does not fail in making its contact the animal will be uninjured beyond being alarmed and startled by the shock.

We have in the engine room a small alternating current machine, made by Siemens Bros. & Co., of London. We will charge its field by the current from an Edison low-tension dynamo, which is ordinarily used for lighting portions of the college buildings. In the field circuit are placed resistances, so that we can obtain any pressure, from zero to 1,000 or 1,200 volts. This is a converter in the simplest form, composed of a core of iron wire upon which is wound a primary of 10 ohms resistance and a secondary of 150 ohms. The dynamo is run at a speed of 1,800 revolutions per minute and gives 288 alternations of the current per second. I would like to have a committee of three from the representatives of the alternating current companies, bring up their voltmeters and test the pressures, but I will ask them to record the same and report to me. If any other persons in the rooms have voltmeters for alternating currents, I should be glad to have them take readings.

I shall commence at the pressure which failed to produce fatal results in the last case.

[Mr. Brown then made the experiments with the results indicated above.]

I will now take the opportunity of replying briefly to some of the letters from the alternating current people, but I shall not notice the personalities with which these letters abound. Personal abuse is out of place in scientific discussions; calling hard names shows how weak are the arguments in favor of high tension alternating currents.

The first person to attack me did not have the manliness to use his name, but wrote an anonymous letter, which was printed in the *Post* of June 19. He commences by stating that I am in the employ of the Edison Electric Light Company, and bases his attack upon that hypothesis. From 1876 to 1879 I was employed in an early venture of Mr. Edison; for nearly five years thereafter I was connected with the Brush Company and located at Chicago; since then I have been interested in an invention of my own, which has been tied up by a four years fight in interference in the Patent Office, and have been earning a living as an independent electrical engineer. I have purchased apparatus for clients of mine from the Edison United Manufacturing Company, but have never been employed by any Edison electric light interest. Even if I had it would have no bearing on the matter; but the writer wishes to give the impression that I am not disinterested in the matter, but am acting from selfish motives.

This gentleman claims to have taken the full force of an alternating current of 1,000 volts; I have sent him a card in care of the *Post*, and would ask him to step forward and name the voltage that he will dare to take in your presence. He says that railroads and steamboats, etc., are dangerous, but that nobody tries to stop them, therefore his current, which is perfectly safe, should not be reduced in pressure. With all of the dangers of modern civilization except high-tension electricity, there is some evidence to the senses to warn people to beware. The moving locomotive, the dangerous bob-tail horse car, the insinuating buzz-saw, can be seen and heard. Escaping gas can be smelled, over pressure in steam boilers is shown by the steam gauge; but high tension electricity may lurk in two iron steps, one connected to the circuit and the other grounded; it cannot be detected or even suspected in many cases until the damage is done. Therefore the public has a right to insist that every precaution known to science be thrown about its use by law.

This unknown refers to a former device of my own for long-distance electric lighting, as do several of the others. I will say right here that the device referred to, if used on a high-tension dynamo without the protecting devices named in the rules recently proposed by me, would be as dangerous as any other part of an arc light circuit, and I have never advocated its use in the homes, but only in stores and on the streets where the circuits could be kept out of reach. It was for operating a definite number of incandescents for definite lengths of time, and was not suited or designed for house use. The subject became involved in a patent interference case and the device was, and is, withdrawn from sale. I think that Mr. T. Carpenter Smith, who makes the same charge against me, was at one time an employé of a company using Brush arc lights and that he then used and sanctioned a similar device of the Brush Company for incandescents upon an arc circuit. Mr. S. C. Peck, who is, I believe, an employé of the Thomson-Houston interest, makes the same charge against me. This gentleman may remember that his company at one time installed a large number of similar devices, one of which killed a man at Hartford, Conn. Mr. M. M. M. Slattery joins in the same cry against me, and he was but a year or so ago engaged in manufacturing and selling apparatus exactly similar to one of my devices for the same purpose, at Woburn, Mass. Their attacks upon me on that head must have been made upon the supposition that I had a very short memory.

But to return to my unknown assailant. He states that the "exploded form of quasi-insulation" (meaning underwriters' wire) "is no longer used." The company in Harlem to which he refers seems to be still using it. He states that "Mr. Brown says there is nothing between the two circuits" (meaning the primary and secondary circuits in the converter) "except a thin layer of cotton or silk; this is true in a sense, but in another sense it is entirely incorrect. There are two layers of cotton or silk on each wire, in addition to which there is usually a layer of other insulating material, and the whole is saturated with a compound of specially high resistance, and the converter is provided with fuses in both the primary and secondary circuits as an additional protection."

In all of our experiments this afternoon, the current has passed through the smallest size of fuses used in practical work, and I wish to ask how much protection they afforded. He further states that my fears as to death from the alternating current are "imaginary," and implies that no deaths or serious injuries have ever been caused by the alternating system. Indeed! In this room is a gentleman who was at the Paris Electrical Exposition some years ago, and who sent one of his employés to examine, on the day after the accident, the place where two men, in climbing a wall near the Grand Opera House, in order to get a better view, touched the two wires leading to alternating current lamps, and were instantly killed. On the Czar's yacht, at about the same time, a man was killed by touching the two wires of an alternating current dynamo. In both of these accidents the pressure or voltage was far less than that advocated for use in this city to-day.

Mr. T. Carpenter Smith makes one correction of my article which is true; he says that Mr Witte was killed by a closed circuit armature dynamo. My article was written mainly before Mr. Witte's death, and I see that I neglected to change my figures to correspond. For that I wish to be pardoned, as it was an oversight. This Mr. Smith lays all the blame of fatalities upon the condition of the circuits, and rates me for not calling attention to them. If he will read my article carefully he will see that I did do so. He quotes the oft repeated tale of the painter who fell upon the alternating current wires in Pittsburgh and was uninjured, since the insulation happened to be good, and seems to think that this proves that the currents inside of the insulation could not have been dangerous. To offset this story, which I have no doubt is perfectly true, I will read a little correspondence which may be of interest.

*Mr. E. P. Cooper, Manager American District Telegraph, Trenton, N. J.:*

DEAR SIR: I see from the newspapers that you were injured a few days ago by a shock from the Westinghouse alternating current line. I am to appear before the Board of Electrical Control next Monday to demonstrate the dangerous character of the alternating system, and would be greatly obliged to you if you will write me by return mail, giving full particulars concerning the accident, with all details, saying whether the day was wet or dry, how you got the shock, its results, etc. Trusting that you will be able to make a prompt response.

I remain, very truly yours,
(Signed) HAROLD P. BROWN.

NEW YORK, July 26, 1888.

ANSWER.

DEAR SIR: It was a clear, dry day, working on a ladder; cause, pulling an iron wire over primary conductor of an alternating machine; was thrown from the ladder, and lighted in a gutter in water and mud and was severely handled; being alone, could not let go of iron wire. The insulation of the electric light wire was to all appearances perfect. The shock was very severe; and thought the time had come to pass in my checks. Excuse me, but I don't care to "wrestle" with the animal any more. I was laid up for a day, and feel the effects of it to-day.

Very respectfully,
(Signed) R. P. COOPER.

TRENTON, N. J., July 27, 1888.

It seems that this insulation is not everywhere as perfect as it is in Pittsburgh. Mr. Smith asks why the Edison company purchased the control of the Ziperpowski alternating current system. As I did not know I called upon Mr. Edison last Friday evening and asked him. He replied that as the Edison Electric Light Company was managed by business men, and as the Westinghouse people had made such great claims for the alternating current, they determined to purchase the system. They did so against his protest (but paid a very small price for it), but they would never put it upon the market.

This Mr. Smith states that he has received the full current of a thousand-volt machine several times and it simply makes him feel better apparently. I will ask him to come forward if he wishes to do so and take a few hundred volts to prove his belief. Let me introduce some more correspondence which will show that Mr. Smith could not possibly have received this current without being at least crippled.

I quote from the *World* of July 14:

"PARKERSBURG, W. Va., July 13, 1888.—Manager J. E. Mayhew, of the Telephone Exchange of this city, was repairing a wire which had fallen across the wires of the Electric Light Company to-day, when the current was turned on. It caught Mayhew at the top of the pole and shocked him into insensibility. He hung forty feet above the street, jerking to and fro, while his shirt caught fire and his flesh burned, in view of a crowd of people. His assistant ran up the pole, cut the wires and brought Mayhew down. He was severely burned about the arms and body, and, it is feared, fatally injured."

I at once wrote for particulars and received the following:

"DEAR SIR: In reply would say that J. E. Mayhew was burned on Friday, the 13th, at 3 P. M., by an incandescent Westinghouse 650-light machine, running at full speed and a head of 30 pounds of steam and a thousand volt current. There were 650 lamps in circuit, but not more than 50 then burning. The wires are under the telephone wires, and a splice had been left bare and had never been insulated. He is very badly shook up, his whole nervous system broken up and his right arm burned to the bone. All the muscles are burned crisp, also the right hand badly burned where he held the wire in his hand. The line he held in his right hand, and the arm above the elbow laid across the telephone wire and burned it out, also the annunciator on the board. This was done through his arm, so you can judge what kind of current it was. The time the current struck him he was on top of a 35 foot pole and fell across the cross arm and the wires, held up until his assistant at the wires went up and carried him down. His clothing was burned off his arm. He is some better and will probably get well, but his arm will be crippled. I am one of the operator's at father's office, and am thirteen years old, and as he could not answer your letter I will try the best I can. Respectfully yours,

(Signed) CLARA MAYHEW.

"PARKERSBURG, W. VA., July 16, 1888."

A current which, passing from this man's hand, up his arm, through his clothing to a telephone wire which, of course, was grounded, could burn off the heavy iron wire and all the receiving apparatus in the office, is not one which can be received with impunity. Had Mr. Mayhew received this current from one hand to the other it would undoubtedly have killed him. And even this was not the full current from one of their alternating wires to the other; it was simply the leakage from a single alternating current wire to the ground.

Mr. S. C. Peck is the next to attack me. He says that the alternating system is perfectly safe, because the primary and secondary coils of the converter are "separated by a very substantial septum of insulating material thoroughly dried and shellacked, and, finally, the secondary or interior circuit is soundly connected to the earth." This introduces a very decided element of danger. Suppose a well-appointed house, equipped with a telephone and lighted with incandescent apparatus of this kind. A contact between the primary wire and the telephone wire has been made and the grounds burnt off by the primary current, as in the case just quoted. The householder wishes to use the telephone and has no means of knowing the dangerous condition of the wires. He turns the bell crank but there is no sound; he lifts the telephone from the hook and turns on his alternating incandescent lamp. As he does so he touches the yoke of the call box which is connected to the primary circuit, and touches the socket, which is connected with the ground, and he is instantly killed. The electric light company at once says that it must have been heart disease, and if not it was all the telephone company's fault. Mr. Peck may say that his company's lamp sockets are not connected with the circuit, but are perfectly insulated. But Mr. W. L. Wright says under oath that "The wiring had then been changed and connected to a 1,000 volt alternating current, and, forgetting that this current would be on the socket, I took

hold of the socket while standing on the wet ground, when I received a shock which threw me on my face with my hand underneath me and still grasping the socket."

Now Mr. Peck says that the house wires are perfectly insulated from the primary or dangerous current, while Mr. Wright says under oath that he got the 1,000 volt current from the socket. Which is telling the truth? Later in his letter Mr. Peck, after telling how safe it makes his system to make a permanent ground connection upon the secondary circuit, says that "a constant ground on a high tension dynamo is poor engineering." He thinks that the present practice of testing lines every day is much better. But ground connections are liable to occur at any hour our of the twenty-four and testing once aday may not find it.

Let me show you how thoroughly most of the station managers test for grounds. They generally have a magneto-electro call bell similar to a telephone call; they connect one terminal to the ground and the other to the line and turn the crank. If there is no ring they conclude that the line is perfectly insulated. Now with this apparatus I can give any person here a painful shock without the slightest ring of the bell, and as in certain conditions, the arc current can kill even though it passes through the resistance of a human body, it is evident that a ground sufficient to cause a fatality may exist and not be detected by this apparatus.

Mr. Peck has also discovered that I am in the employ of the American Company, and that my bias in favor of this system is the reason for all my zeal. There are several representatives of that company present, and any one taking that view of the case is referred to them. Possibly Mr. Peck does not remember that there are many other closed circuit armature dynamos besides the American.

In his letter he states that "there is no self-induction of any moment to produce the dreaded extra current" (there he is right) "and opening the circuit" (the alternating current) "and introducing one's self into it merely subjects one to the pressure of 1,000 volts, which has never yet proved fatal." Can Mr. Peck ever read the newspapers? Such statements as that are simply incendiary. What would be thought of a physician who published a statement that arsenic had never been known to produce fatal results and advised every one to use arsenic for sweetening coffee.

I will quote again from the New Orleans *Daily States* of Sept. 23, 1887:

"Several accidents have happened of late to linemen of electric light companies, who have been knocked senseless by coming in contact with wires while in the performance of their duties. Tuesday last a lineman in the employ of the Edison Light Company was knocked from a pole at the corner of Canal and Carondelet streets by receiving a shock from a wire charged with the alternating high-tension current from the Westinghouse machines used by the Brush Electric Light Company. The accident was the second serious occurrence in this city from the Westinghouse alternating current. Fortunately, it has not so far turned out to be fatal, as did the accident of a month ago, which occurred as follows: The unfortunate man who was killed was at work on a pole pulling up a dead arc wire, when his foot slipped, and he fell across the wires carrying the alternating current, which wires had been bared of insulation in order to tie them in firmly to the insulators. The man was suspended by the wires, and the current passed through his body from the inside of one thigh to the upper ribs on the other side, the flesh being burned to the bone in both cases. It was probably five minutes before they could switch off the current from him, and by that time he was stone dead.

"Two serious accidents, one being fatal, from the alternating current in the course of five weeks, render it necessary to call attention to this new element of danger in the streets, and to consider what precautions should be taken. The alternating system is new in this country, and very little experience has been had with it compared with the arc system. However, this experience has shown that this current is quite as dangerous, if not more so, than the arc current, which has killed so many men. There are two reasons for this: First, the full pressure of current (1,000 to 1,200 volts) is on every pole in circuit; second, the wires running parallel with one another, only a short distance apart, it is very easy to obtain a shock; in fact it is very difficult for a man working on a pole to avoid receiving a shock sufficient to knock him from a pole, and should he be suspended and unable to free himself, as occurred in the fatal accident referred to, the shock quickly proves fatal."

In order to learn whether any more men had been killed in New Orleans since these accidents occurred, I telegraphed last week and received this reply from a reliable gentleman: "In September, 1887, lineman of Brush Company at work on lines fell across and was killed after being burned to the bone. In October telephone employé threw his wire over Westinghouse line and was instantly killed. Cannot get further particulars at the moment."

Mr. M. M. M. Slatterry repeats the same tale with variations. He says: "After an extended practical experience of three years by those who have carefully followed the alternating system in use, and after many physiological experiments, frequently involuntary ones, to determine the safe limit of pressure to work with, it has been found that no fatality can occur or serious inconvenience result from a shock from an alternating current having a pressure of that already cited, 1,100 volts." But soon after he forgets what he has said and makes this admission: "Now in this case we want to prevent the dangerous current reaching the users of lamps; we know the current is dangerous; practical experience has so informed us." Very well said; it is perfectly safe, but we know it is dangerous. This gentleman puts 1,100 volts as the limit that can cause no fatalities. I will quote again:

"*Telegram to the Herald. Buffalo, N. Y., Feb.* 5, 1888.

A fatal electric light accident happened at 1 o'clock this morning. Robert Taylor, driver of the delivery wagon of the Pioneer Co-operative Grocery Store, was making his way down Michigan street, in the blinding snow and rain storm. At the corner of Eagle street his horse dropped, and at the same moment Taylor received a severe electric shock through the lines. He was dazed for a moment, and even after he recovered did not comprehend what had happened. He got down, seized his whip and started to prod the prostrate animal, but was knocked down unconscious by a second shock. A colored man, who was standing on the sidewalk, came to his relief and attempted to help the horse. He was heard to yell terribly for the space of five seconds, and then all was still. Policemen Hennessy and Haley ran up, thinking it was a murder, but in a moment they had the colored man in Smith's drug store pouring whisky into him. Drs. Hanley and Mulhern came over from the Emergency Hospital on the corner below, and removed the unconscious man with them. As he passed through the hospital door his heart stopped beating and he never knew anything after the current struck him. His hands were terribly burned, the fingers being cut to the bone. He was identified at two o'clock as Isaac Morton, of La Fayette street, Detroit. The Brush electric light man found that a telephone wire had broken and fallen into the street, making a cross with one of their wires. The wire was found tangled about the horse's feet."

And yet Mr. Peck thinks testing for grounds once a day is sufficient to prevent any mishap. It does not state in the article what current killed this man, but there is a gentleman present who was told by one of the Brush men at Buffalo that the ground which caused this accident was upon one of the primary wires of an alternating current dynamo operated at the Brush station.

One of the electrical papers this week states that Mr. Slattery's letter proved that I had opened my mouth and put my foot in it. Here is one of Mr. Slattery's statements that undoubtedly caused me to perform this singular gymnastic feat: "In point of fact the low tension current at 220 volts in underground conductors offers a far greater strain upon insulation than an alternating current at 1,100 volts."

Let me contrast this with the statement of Professor Morton upon the same subject, upon which, by the way, Professor Morton is high authority. "Even the Edison wires in New York are frequently being torn up to repair injuries due to loss of insulation, notwithstanding their very low electro motive force of but 110 volts, as any one can see who has occasion to go about the streets traversed by the Edison conductors down town. When currents of twenty times this electric pressure, as it has been aptly called, are used, this tendency to rupture the insulation is proportionately increased."

Prof. Morton does not quite get my meaning in referring to the galvano-faradic coil. I desired in a simple way to give the average newspaper reader a slight idea of the effects of pulsations or interruptions, and did not intend to compare this apparatus with an alternating current dynamo. His criticisms upon my Rule 1 I must admit as well founded. Let us, then, change it so as to read as follows: "Not more than 3,000 volts shall be used upon any arc light circuit." He is also right in stating that some volume of current is necessary, if accompanied by enough electromotive force to carry it through the body, in order to kill; but he is mistaken in assuming that it requires considerable volume. In one of our laboratory experiments (No. 27), a fox-hound, weighing 56 pounds, was killed by a current, alternating 288 times per second, at 160 volts E. M. F. His resistance was 27,500 ohms, and the calculated current would therefore be exceedingly small. We found, however, that when we used continuous currents and could measure the ampères that produced fatal results, the indicated current was much larger than the calculated current, showing that the resistance had been reduced by the current itself. We had no ammeter for alternating currents, and could therefore make no observation, but from our experience in the dropping of the resistance when we reversed the galvanometer current in measuring resistances of living beings, I should assume that the actual current would be at least three or four times as large as the computed current.

Mr. Shallenberger has discovered an electric current that does not decompose an electrolyte. He says: "There is a very convincing reason for the small danger due to alternating shocks to the human body, as compared to those received from the direct current, namely, the fact that the conducting fluids are more or less decomposed or electrolyzed by the passage of the direct current, while it is well understood that such an effect is not produced by the alternating current."

Mr. Shallenberger is respectfully referred to an article in the London *Telegraph Journal and Electrical Review*, of July 6, where he will find an article upon "Electrolysis by the Alternating Currents of Dynamo Machines,' which he can read to great profit. If he will connect a voltameter to his alternating current machine, having very fine platinum wires for electrodes, he will observe an exceedingly brisk decomposition of the electrolyte, producing the gases in a dangerous mixture of oxygen and hydrogen at each pole. I do not think he can cite a case in which a death has been caused by electrolysis from a direct current dynamo. Mr. Shallenberger also has received 1,000 volts without injury, and ends his article by stating that the alternating system (Westinghouse) is "absolutely safe" both to life and property.

If these people would but say to the public: "Our system is extremely dangerous; you must handle it with great caution; we take every possible precaution to protect you, but you must not be reckless," one could forgive much. But when they set it up as absolutely safe and instruct their agents and engineers to tell the public so, it is time for them to receive a sharp lesson. It is a common thing for engineers in charge of alternating current stations to say, when visitors ask whether the current is not dangerous, "O no, I can put my hands on both brushes" Then, to illustrate, he puts his hands on both brushes—of the little dynamo used to excite the fields of the alternating current machine, and having a continuous current of very low voltage. This story has come to me from several different gentlemen, who have seen the thing done; there are two of them here this afternoon. But if the visitor pretends that he is going to put his hands on the brushes of the alternating current dynamo, the attendant nearly breaks his neck in his endeavors to keep him away. Perhaps this is the 1,000 volt current that so many of these gentlemen have taken so often without injury. Mr. Byllesby is candid enough to admit that 1,000 volts may prove fatal, and I congratulate him upon his honesty.

The advocate of The Safety Electric Light and Power Co. should be required to change the name of his company before it is given permission to operate in this city, or to reduce the potential to a voltage which this afternoon's experiments have proved to be safe.

Mr. S. G. Smith is an advocate of the safety involved in testing circuits occasionally, with (I presume), the usual magneto call bell. He is right in stating that a ground connection, even through high resistance, would be a strain upon the insulation, but it would not be one hundredth part of the strain caused by a telephone wire's dropping upon the circuit during the night's run. This gentleman thinks that there is no occasion for the fifth rule suggested by me. Does he not remember that in the same issue of the *World* which told of Mr. Murray's death, was the report of the death of a young man at the park, in, if I remember right, Syracuse, who saw the electric wire break, and then sparkle upon the ground. He picked it up and was killed.

I cannot close without a reference to the absurd affidavit of Mr. W. L. Wright, who solemnly swears that he feels sure that if he had received "this kind of a shock from a direct current machine of any of the ordinary types that it would have been fatal." If we are to believe all the other advocates of alternating currents, it is simply impossible for the 1,000 volt current to have been on that socket. The truth probably is that he received a slight leakage to the ground from the secondary. But if it is really true that all these men have taken 1,000 volts alternating current without injury, investigation will probably show that they all wear lightning rods.

I have proved by my experiments that a steady, continuous current can be withstood without injury, even at very high potentials; that breaking or alternating the current will produce death at a much lower pressure; that the more rapid the alternations, the lower the pressure required to kill. These demonstrations cause all the voluminous objections of my assailants to lose all weight. I have shown that a continuous current will not kill at 1,420 volts if an apparatus is provided to receive the extra current. I think I am, therefore, justified in asking this Honorable Board to adopt Rules 1, 2, 3 and 6, and leave the others until I can prove upon arc light apparatus that they are practical and effective.

Let us consider what hardship, if any, is involved by the adoption of Rule 6, limiting the voltage of alternating currents to 300 volts. It means simply this: That the alternating current companies will have to put in mains having three times as much copper as that required with their present voltage. They now say that the cost of their mains is inconsiderable; very well; force them to multiply the cost by 3½ and it will not ruin them. At the same time the insulation resistance can be reduced in the same proportion, which will effect a saving in first cost and in leakage. What is gained by forcing this wealthy corporation to buy a few thousand pounds more copper? Safety from sudden death.

The following paper was then presented by Dr. Frederick Peterson.

REPORT OF EXPERIMENTS SHOWING THE EFFECT OF CONTINUOUS AND ALTERNATING ELECTRIC CURRENT ON LIVING ANIMALS.

The effects of electricity upon the human body have been a matter of deep interest and study to the medical profession from time immemorial, more particularly in earlier days, in its powerful form of lightning, and during the present century as a remedial agent.

On the persons of human beings lightning often strips off, tears or burns clothing, oxidizes or melts buttons and watch chains and renders knives magnetic. It may burn the skin and hair, lacerate and perforate the body, fracture bones (*Taylor*), cause extravasations of blood anywhere in the body, such as apoplexies of the brain or meningeal hemorrhages, amputate a limb (*Sycanko, Berl. Klin Woch.* 1868), or cover the body with curious hyperæmic arborescent marks. Some die from the injuries received only after the lapse of considerable periods of time, as from tetanus in four hours (*Taylor*), or hemiplegia in a month (*Bugge*).

Of perhaps a third struck by lightning who live, most are subject to nervous diseases in various forms. They may be unconscious for hours or days, become delirious, even maniacal, have all sorts of paralyses and losses of sensation, be affected with blindness or deafness, or have convulsions, epilepsy or neuralgia. Heusner relates how a thunderbolt struck twenty people, killed four, burned or lacerated the clothing and skin of the rest, and in many made peculiar openings in the soles of the feet as it passed through their bodies into the ground.

The changes to be found on making a post-mortem examination are almost wholly coarse lesions visible to the naked eye, such as laceration of the brain or other organs. *Rigor mortis* is said to appear early (*Goguel*), and often there is a cataleptic *rigor mortis* at the moment of being struck (*Woodman* and *Tidy, Handbook of Forensic Medicine*), so that persons are found dead in precisely the attitudes last assumed when living. The blood is dark and unusually fluid.

Of course, the number of volts of E. M. F. in a stroke of lightning is enormous, probably beyond our ascertaining.

Lightning may be imitated by means of frictional electric machines and discharges from Leyden jars. Two men have experimented upon lower animals with this artificial lightning. In 1869 Dr. B. Richardson (*Medical Times*, 1869) used the gigantic induction apparatus of the Polytechnic Institute in London (weight 15 cwt., length of primary coil 3,770 yards, of secondary coil 150 miles and 41 Bunsen elements). With discharges from this machine and Leyden jars he killed sheep and rabbits. Post mortem examinations were then made by Dr. Sedgwick. The blood vessels of the brain were often found distended, the heart gorged on the right side, empty on the left, the intestines intensely congested and the blood black and fluid. At the same time he passed a shock through bright red blood in a test tube, turning it immediately black, then reddened it again in a jar of oxygen, and again repeated the experiment, thus proving a chemical effect of the electric shock on the blood.

In 1880, Prof. Nothnagel, of Jena (*Virchow's Archiv.* vol. lxx.), experimented on a rabbit with discharges from Leyden jars with an ordinary frictional electric apparatus. He did not kill the animal, but produced anæsthesias and paralyses, which lasted generally but a few hours, and concluded that it is seldom that lightning injures nerves permanently, that animals are either killed at once or recover from the effects of the stroke.

In medicine our most important electric remedy is the continuous current. The continuous current of a battery may be made to alternate by means of the commutator, producing shocks known as "voltaic alternatives," in other words, alternations of current.

In studying the physiological effects of the continuous current upon living nerves it is found that the action of the positive differs from that of the negative pole. The irritability of the nerves is peculiarly altered by each. The phenomena produced are designated as electrotonus. The excitability of the nerves is diminished in the neighborhood of the positive pole or anode and increased in the neighborhood of the negative pole or cathode. These states are respectively termed anelectrotonus and

catelectrotonus. Whenever the continuous current is made or broken a contraction of the muscles supplied by the nerves takes place, the closure contraction at the cathode being strongest. It is evident, therefore, that if a continuous current passing through the body be suddenly reversed or alternated, and travel in the other direction, that there is also a reversal of the effects of the two poles. So that the diminished irritability at the anode not only goes back suddenly to normal but passes that and becomes the increased irritability of the cathode. Hence an alternation of the direction of the current is twice as powerful, its shock twice as great, as that of a mere interruption of the current. To the truth of these statements every physician familiar with electricity and every book on electrical therapeutics and electro physiology will bear witness.

In medical practice we use batteries of comparatively small voltage, generally from 10 to 100 volts, and in treatment we encounter resistance in the human body. The skin is the chief obstacle to the passage of the current, the resistance of the intermediate saline fluids and tissues being almost negligible. "2,500 ohms may be assumed to represent the average resistance of the human body in the usual medical application." (*De Watteville.*) Consequently physicians do not measure current strength by the ampère, but by the $\frac{1}{1000}$th of an ampère, or milliampère. We rarely use even 30 milliampères current strength in the treatment of nervous diseases, but sometimes 200 to 500 for the electrolysis of tumors. But even with the mildest currents, scarcely felt when passing continuously through the body and not much felt when the current is simply made or broken, an alternation may produce considerable pain. Indeed, such an alternation if passed through the head will cause giddiness and nausea. De Watteville, our best authority, says, in his book on "Medical Electricity:" "Voltaic alternatives, as such current reversals are called, are indicated where a still more stimulating application than interruptions is required, and a corresponding degree of caution must be exercised in their use."

I am willing to demonstrate on any one here present that alternating current shocks are more powerful and severe than a continuous current on its mere interruption. As a current will stimulate a nerve in something like $\frac{1}{1000}$ths of a second, it is clear that when the continuous current is closed upon a body for any limited space of time, there is but one shock at the closing and one at the opening of the circuit; whereas, with an alternating current for the same interval of time, the shocks are twice as strong and as many in number as there are reversals of the current per second. If the stimuli are too numerous, say over sixty-five per second, a condition of tetanus is produced in the muscles supplied by the nerves stimulated. The same fact holds good as to currents of any strength. From this it must appear plain that if a continuous current, say of 1,600 volts E. M. F., is sufficient to cause death, then an alternating current of much less than half that voltage must be fatal under the same conditions.

This is well illustrated in the experiments recently undertaken. Dog No. 5, weighing 50 lbs., took in succession the continuous currents of 1,000, 1,100, 1,200, 1,300, 1,400 and 1,420 volts, the last the highest voltage at command, and a few minutes later 1,200 volts for two seconds, and was unhurt by any, skipping about as well as ever when released. Dog No. 6, weighing 55 lbs., was given a 300 volt current, alternating 4,100 times a minute, for two seconds, which caused him to howl and struggle, bite his tongue and bleed at the mouth; then another of 400 volts for two seconds, then a shock of 500, and finally 570 volts of alternating current for three seconds, which killed him. During the latter three shocks the dog was silent and motionless. In dog No. 3, weighing 13¼ lbs., 1,000 volts continuous current was fatal, while dog No. 4, weighing more than three times as much, and with 5,000 ohms more resistance than No. 3, was killed by an 800 volt current alternating 2,200 times per minute.

The shocks by the alternating current caused more exhibition of pain, as manifested by greater howling and struggling after opening the circuit, than did those of the continuous current. But the more numerous the alternations per second the greater the number of powerful stimulations, and hence the more serious injury.

Dog No. 2 died from an 800-volt current alternating 1,600 times per minute applied for 3 seconds. He consequently received more than 26 voltaic alternatives per second, or altogether about 80 voltaic alternatives. Dog No. 4 died from an 800-volt current alternating 2,200 times per minute, applied for 2½ seconds, or 91 in all. I am sure a smaller voltage would have killed that dog. Now, since each alternation of the current gives twice as great a shock as an interruption of the current, it follows that the more numerous the alternations of a powerful current the more decided will be its effect. Consequently by increasing the number of alternations per second, we should expect a smaller voltage to be fatal. This is exemplified in the case of dog No. 6, killed by but 570 volts, the number of alternations having been increased to a little over 68 per second, the duration of contact being 3 seconds. This dog, therefore, received 195 voltaic alternatives. When, with dog No. 7 the E. M. F. was reduced to only 250 volts, while the number of alternations was increased to 288 per second, a contact of 5 seconds killed him at once. Dog No. 8 was killed with but 160 volts E. M. F., administered for 5 seconds, with 288 voltaic alternatives per second.

It is in fact startling to see how small a quantity of E. M. F. is required, provided the alternations of the current be multiplied. In each dog the current was passed from the left hind leg to the right fore leg. The legs were thoroughly wet, wound with wet cotton waste and bare copper wire to which the rheophores were attached, and the animal insulated in a dry wooden box standing on a rubber mat. No external burns or lacerations were made by the currents in any of the cases. There was a tendency on the part of the shocks to diminish the number of respirations, and fatal shocks with either current caused respiration to cease before the heart stopped beating. No. 5, who took several severe continuous current shocks, and finally 1,420 volts, all that could be obtained in the laboratory, without injury, was panting at the rate of 120 times per minute at one time, but several shocks reduced the panting to 60 per minute.

Most of the fatal shocks caused relaxation of the sphincters of the bladder and rectum, with involuntary discharge of their contents. Attaching the rheophores, as was done to the fore and hind legs, the current would, by diffusion, pass through the whole trunk, in all probability traversing all the important viscera, besides the larger nervous bodies, the spinal cord, sympathetic system and the pneumogastric and phrenic nerves. There is one muscle that would receive almost the whole of such a current, and that is the chief muscle of respiration, the diaphragm, with the phrenic nerves distributed throughout its substance. It is possible that a paralysis or tetanic spasm of this muscle causes the immediate cessation of respiration. Dog No. 3 ceased to breathe in two minutes, while the right auricle of his heart continued to beat 36 minutes longer, even after opening the chest. Dog No. 4 ceased to breathe in 15 seconds, while the heart beat for 10 minutes longer. Dog No. 6 ceased to breathe 1½ minutes after he received the fatal shock, but the right auricle continued to beat subsequently for 10 minutes, and 3½ minutes longer under irritation. Autopsies were made immediately after death upon dog No. 3, which died from the continuous current, and on dogs Nos. 4 and 6, killed by the alternating. In all of these dogs the blood was dark and thin, in No. 4 so markedly that the muscles, liver, spleen and kidneys seemed almost black with engorged blood. Immediately after the death of No. 6 I examined some blood from its vena cava under the microscope, but found the red and white corpuscles normal in every respect.

The peristaltic action of the intestines on irritation and the mechanical irritability of the whole muscular system lasted in No. 3 over half an hour, and in Nos. 4 and 6 for 10 minutes. Current not having passed through the brain, that organ was not examined in any of the cases. All other organs were inspected in the three dogs. The lungs were normal in all. The heart was gorged with blood on the right side, and empty on the left in all. The movements of the heart were limited to the right auricle and its appendix. The abdominal viscera were normal, save for their turgidity with blood. There were no extravasations of blood anywhere in them.

I examined then the muscles of the legs attached to the rheophores. In No. 4 there was some separation of the thigh muscles and some extravasations of blood between them; in the other two dogs nothing of this kind. I removed for microscopic examination portions of a large nerve from the legs of all the dogs to which rheophores were attached, and also in No. 6 a sciatic from the sound side for comparison. From Nos. 3 and 4 I took several inches of the spinal cord in the dorsal region. Some of these I examined fresh and some after several days maceration in a solution of bi-chromate of potash. There was a slightly granular condition of the sciatic nerve of dog No. 3, this nerve lying so closely in a small dog to the electrode that in this instance it probably got the brunt of the current. The nervous parenchyma in other parts of the same dog was entirely normal. The substance also of the spinal cord was apparently normal, as viewed under the microscope. But in No. 3 I found the capillaries of the sheaths of the nerves under the spinal cord irregularly gorged with blood, and with here and there capillary extravasations; and this condition was even more marked in No. 4. It is a state known as capillary ectasy more due to paralysis of the walls of these minute blood vessels. No. 6 died in a state of tetanic rigidity. There seemed to be no certain pathognomonic signs of death by electricity. The changes it produces are peculiarly protean. It enters the body dividing the molecules, separating atoms, disarranging the fine molecular structure of the body, exerting both a chemical and mechanical action, now at one place, now in another, so that, as a rule, neither the eye nor the microscope is able to discover what vital centre has been disturbed or destroyed. It changes the color of the blood by chemical action. It produces gross lesions in the organs by its expansive force, just as an egg or the head of a bird receiving the discharge of a Leyden jar by means of small wires inserted into its opposite sides, is blown to pieces.

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As many criticisms were made with regard to the manner in which the first experiments of Mr. Brown had been carried out, and which were deemed to be unfair to the alternating current, that gentleman resumed his experiments on Friday, Aug. 3, when he experimented with the alternating current exclusively upon three dogs. The first dog, measuring 14,000 ohms resistance, was given the current at a pressure of 272 volts, which was continued for 5 seconds and proved fatal. The second dog, with a resistance of 8,000 ohms, was given the current for 5 seconds, at 340 volts, which also proved fatal. The third dog was likewise killed at 234 volts with the current on for 30 seconds. These experiments were made in the presence of Dr. Cyrus Edson, of the Board of Health; Dr. Roberts, of Bellevue Hospital College; Dr. Peterson, Dr. Frank Ingram, Dr. S. S. Wheeler, Capt. Zalinski and a number of others. It is proposed to continue these experiments in order to determine the best arrangement for the killing of vagrant dogs, and also as to the execution of criminals.

## Experiments with Electric Currents on Dogs.

BY HAROLD P. BROWN.

In these experiments the following instruments were employed:

A dynamo of the Edison type, capable of giving an E. M. F. of 1,500 volts or less, with variable resistance in the shunt field circuit.

One voltmeter of the Howell type, 800 to 1,500 volts.

One Ayrton & Perry spring voltmeter, 30 to 130 volts.

Two French (Carpentier) voltmeters, maximum 140 volts.

One ammeter, graduated to $\frac{1}{10}$ ampère, maximum 1 ampère.

The electrical connections employed in these experiments are given in the accompanying diagrams. Fig. 1 shows the connections for the 5th, 6th, 7th and 8th experiments, in which the lamp resistance is placed in shunt with the body of the dog. Fig. 2 shows the relay connections in the remaining experiments wherever mentioned, the lamps being now in series with the body of the dog. In the diagrams *D* represents the dynamo; *S*, resistance in field; *R*, relay; *b*, back contact; *l*, 97 volt lamp in shunt with relay magnets; *L*, eight 97 volt lamps in series; *N*, ammeter; *V*, voltmeter; *K*, key.

*First Experiment.*

Dog No. 1. Old black and tan bitch; low vitality; weight not taken (about 10 lbs.). Resistance from right front leg to left hind leg, 7,500 ohms. Connection made through roll of wet cotton waste, held in place by wrappings of bare copper wire; continuous current used, with no provision for taking the extra current from field caused by breaking circuit through dog; no load on dynamo.

E. M. F., at time of closing circuit, 800 volts; time of contact through dog, 2 seconds; current started rapidly at 0.1 ampère and rose rapidly to 1 ampère; time of experiment, 10:06 P.M., July 10, 1888.

Behavior of dog: Howled vigorously and made violent efforts to escape, showing that it had control of muscles and that nerve functions were not destroyed. Howled loudest as circuit was broken. Continued howling and rushing about for two and a half minutes after circuit was opened, then dropped upon its side. Pulsation of heart detected until 10:21 P. M.

*Second Experiment.*

Dog No. 2. Large half-bred St. Bernard puppy; strong and in good condition. Weight not taken (about 20 lbs). Resistance from right front leg to left hind leg, 8,500 ohms. Connections made as above and wet after first and second trials as well as before first trial. Continuous current used with no provision for taking the extra current from field caused by breaking the circuit through dog; no load on dynamo.

E. M. F. at time of closing circuit, 290 volts. Time of contact through dog, 2 seconds. Current, 0.1 ampère. Time of experiment, same evening as above.

Behavior of dog: Howled during time of contact and tried to escape. Easily quieted and entirely uninjured.

*Third Experiment.*

Same dog as second experiment. Same connections. Alternating current used by introducing a circuit breaker and alternator in circuit with the dog. No provision for taking extra current from partial discharge of field, and no load upon dynamo.

E. M. F. at time of closing contact through dog, 290 volts. Number of alterations, 660 per minute. Time of contact through dog, 2 seconds. Current, no reading could be made. Time of experiment, same evening as above.

Behavior of dog: Was made perfectly rigid during time of contact, unable to howl or move until current was broken, then howled and made feeble efforts to escape. Continued whining until third trial. A longer time of contact was decided upon for next trial since the circuit breaker and alternator made contact during but a small portion of each revolution.

*Fourth Experiment.*

Same dog and same connections. Alternating current as in previous trial. No provision for taking extra current and no load upon dynamo.

E. M. F. at time of contact, 800 volts; number of alterations, 1,600 per minute; current, no reading could be made.

Length of contact, 3 seconds; time of experiment, same evening as above.

Behavior of dog: Was turned into rigid mass during contact, no motion or tremor visible; at opening of circuit it fell with all muscles limp, howled faintly with a single expulsion of breath and died in fifteen seconds after circuit was closed. Muscles remained limp after death while muscles of first dog were stiffening.

*Fifth Experiment.*

Dog No. 3. Fox terrier bitch; young and of good vitality; weight, 13¼ pounds; height, 13 inches; length from tip of nose to base of tail, 24 inches. Resistance, 6,000 ohms. Connections made as above and kept thoroughly wet. A relay was provided to close circuit upon a series of lamps as soon as circuit through dog was opened in order to receive extra current from partial discharge of field.

Continuous current; E. M. F., 400 volts; current, 0.05 ampère; circuit closed at 9.35 P. M., July 12, 1888.

Dog howled and struggled but unhurt.

*Sixth Experiment.*

Same dog and same connections; relay used as in previous trial to take extra current.

Continuous current: E. M. F., 600 volts; current, 0.1 ampères; circuit closed at 10:04 P. M.

Dog howled and struggled, but unhurt.

*Seventh Experiment.*

Same dog and same connections; relay used as in previous trial to take extra current.

Continuous current; E. M. F., 800 volts; current, 0.15 ampère; circuit closed at 10 07 P. M.

Dog howled and struggled but unhurt.

*Eighth Experiment.*

Same dog and same connections; relay used as in previous trial, to take extra current.

Continuous current; E. M. F., 1,000 volts; current, 0.25 ampère at first, then rose to full extent of ammeter. Relay contacts apparently poor, as lamps did not start immediately as in previous trials with same dog. Circuit closed at 10:12 P. M.

Dog howled and struggled violently for two minutes, then apparently died. Dog immediately dissected by Dr. Frederick Peterson, and heart found still pulsating; peristaltic action of intestines continued and frequent quiverings of muscular tissue noticed. Heart continued pulsating until 10:50. Opinion expressed by Dr. Peterson that artificial respiration would have saved its life if resorted to immediately after moment of apparent death. Sections of spinal cord and sciatic nerve taken out by Dr. Peterson for microscopic examination.

*Ninth Experiment.*

Dog No. 4. Half-bred bull dog, strong and vigorous. Weight, 46½ lbs.; height, 21 in.; length from tip of nose to base of tail, 37 in. Connections same as above. Resistance, 11,000 ohms. Use of relay discontinued, but series of lamps permanently connected with dynamo, since alternating current would not have actuated relay.

Alternating current; E. M. F., 800 volts.; number of alterations, 2,200 per minute; current (read by ammeter in circuit with dog, but between dynamo and circuit-breaker and alternator and therefore not on alternating current), 0.1 ampère. Circuit closed at 11:22 P. M. Time of contact through dog, 2.5 seconds.

Dog was placed in wooden box to prevent accident in case he broke loose; slats were nailed across top of box, but these were unnecessary, as during time of contact the dog was apparently turned to stone. When circuit was opened, it fell in a limp heap and died in fifteen seconds after the circuit was closed. Dog immediately dissected by Dr. Peterson; muscular quiverings were observed and blood had a peculiar dark, thin, fluid appearance. Sections

of spinal cord and sciatic nerves taken by Dr. Peterson for microscopic examination.

*Tenth Experiment.*

Dog. No. 5. Half-bred shepherd dog, strong and in good condition; weight, 50 lbs.; height, 23½ in.; length from tip of nose to base of tail, 39 in. Connections same as above.

Resistance, 6,000 ohms; continuous current, relay connected as per diagram, to prevent extra current from field from reaching the dog when circuit was opened. E. M. F., 1,000 volts; current, 0 10 ampère. Circuit closed at 9.40 P. M., July 14, 1888.

Dog yelped once, but entirely unhurt. Did not struggle. Respiration rose to 120 per minute (panting).

*Eleventh Experiment.*

Same dog and same connections. Relay as before to take extra current.

Continuous current ; E. M. F., 1,100 volts ; current, 0.20 ampère. Circuit closed at 9:44 P. M., same evening.

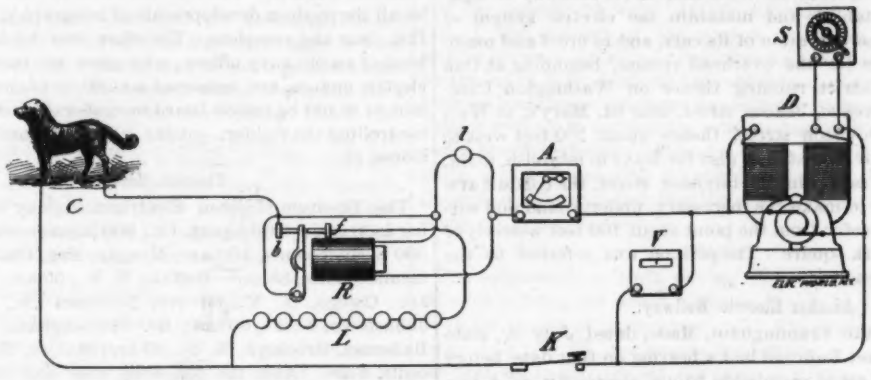



FIG. 1.—EXPERIMENTS WITH ELECTRIC CURRENTS ON DOGS.

Respiration fell to 72 and dog unhurt. Dog yelped when circuit was closed, but wagged his tail as Dr. Petterson counted respiration.

*Twelfth Experiment.*

Same dog and same connections. Relay as before to take extra current.

Continuous current; E.M.F. 1,200 volts ; current, 0.30 ampère. Circuit closed at 9:46 P. M , same evening.

Dog yelped as circuit was closed, but still unhurt. Respiration, 72.

*Thirteenth Experiment.*

Same dog and same connections. Relay as before to take extra current.

Continuous current; E. M. F., 1,300 volts; current, 0.20 ampère. Circuit closed at 9:51 P. M., same evening.

Dog yelped as circuit was closed, but still unhurt. Respiration, 60.

*Fourteenth Experiment.*

Same dog and same connections. Relay as before to take extra current; E. M. F., 1400 volts; current, 0.40 ampère; circuit closed at 9.53 P. M , same evening.

Dog yelped slightly as circuit was closed, but still unhurt. Respiration, 72 (irregular).

*Fifteenth Experiment.*

Same dog and same connections. Relay as before to take extra current.

Continuous current. E. M. F., 1,420 volts, the utmost capacity of dynamo at its present speed; all resistance removed from field circuit; current, 0.20 ampère. Circuit closed at 9:58 P. M., same evening.

Dog yelped, but unhurt. Respiration, 72. Dog removed from box and found to be entirely uninjured. No signs of paralysis in either sensory or motor nerves. To ascertain whether any poor contact existed dog's resistance was retaken. Resistance, 6,500 ohms. As all experiments upon this dog were with a single, instantaneous closing and short-circuiting of dog circuit, it was decided to replace him in box and hold the relay armature for two seconds after circuit was closed, in order to determine whether current for this length of time would be injurious.

*Sixteenth Experiment.*

Same dog and same connections. Relay as before to take extra current, but armature held for 2½ seconds after circuit through dog was closed.

Continuous current; E. M. F., 1,200 volts; current, 0.30 ampère. Circuit closed at 10:30 P. M., same evening.

Dog yelped and struggled during continuance of current, but entirely unhurt. Respiration before closing, 132; after opening circuit, 112. Dog released and found to be entirely unhurt in any way. He was thereupon christened 'Ajax" and adopted by engineer.

*Seventeenth Experiment.*

Dog No. 6. Plain, ordinary dog, strong and vigorous. Weight, 55 lbs.; height, 21 in.; length from tip of nose to base of tail, 35 in. Dog greatly alarmed at being placed in box; emptied bladder and was therefore placed in another box after first closure. Respiration (panting), 234 before circuit was closed. Relay not operated by alternating current and removed.

Resistance, 3,600 ohms; alternating current, 4.100 alternations per minute; E. M. F., 300 volts; current 0.10 ampere; contact closed for 2 seconds at 11:02 P. M., same night.

Dog screamed and howled loudly during time of closing, and made violent efforts to break loose for about one minute after circuit was opened. Respiration very variable, 54 to 30. Dog evacuated during continuance of current. As he had previously saturated the bottom of box it was concluded that a portion of the current passed through the urine and allowed the motion during continuance of current. Dog placed in a dry box.

*Eighteenth Experiment.*

Same dog and same connections.

Alternating current, same number alternations; E. M. F., 400 volts.: current, no reading; circuit closed for 2 seconds at 11:21, same night.

Dog silent and motionless during continuance of current; yelped and howled loudly at opening of circuit and made efforts to escape. Respiration, 165.

*Nineteenth Experiment.*

Same dog and same connections.

Alternating current; same number alternations. E. M. F., 500 volts; current, no reading. Circuit closed for 2 seconds at 11:45 P. M., same night.

Dog silent and motionless during continuance of current. Yelped and howled loudly at opening of circuit, but not as vigorously as before. Continued to struggle to escape. Respiration, 170.

*Twentieth Experiment.*

Same dog and same connections.

Alternating current, same number alternations; E.M.F., 570 volts; current, no indication; circuit closed for three seconds at 11:31 P. M., same night. Length of contact increased to three seconds. since the circuit breaker and alternator makes connection with circuit during but one-third of each revolution. Therefore to compare with the continuous administered for two seconds it should be closed for three seconds.

Dog silent and motionless during continuance of current; moaned with one expiration of the breath as circuit was opened and sank in a limp heap. Died in ninety seconds after circuit was closed. Opinion expressed by Dr. Peterson and myself that along erduration of the alternating current at a less voltage would have proved fatal. Dog immediately dissected by Dr. Peterson. Opened at 11:41 P. M., same night. Auricle contracted under irritation at 11:46 P. M. The same muscular quiverings were observed and blood had a peculiar dark, thin, fluid appearance. Sections of sciatic nerves from each leg taken by Dr. Peterson for microscopic examination.

*Twenty-first Experiment.*

With a Siemens Bros. & Co. alternating current generator for 100 volts, excited by a standard Edison dynamo, operated at 1,080 revolutions, with pulley 15 inches in diameter and a 3-inch belt; 288 alternations per second. Transformer used had iron ring core with primary of 10 ohms and secondary of 150 ohms resistance. A Cardew voltmeter was used for measurements of potential and the strength of current was varied by introducing resistance in the exciter circuit.

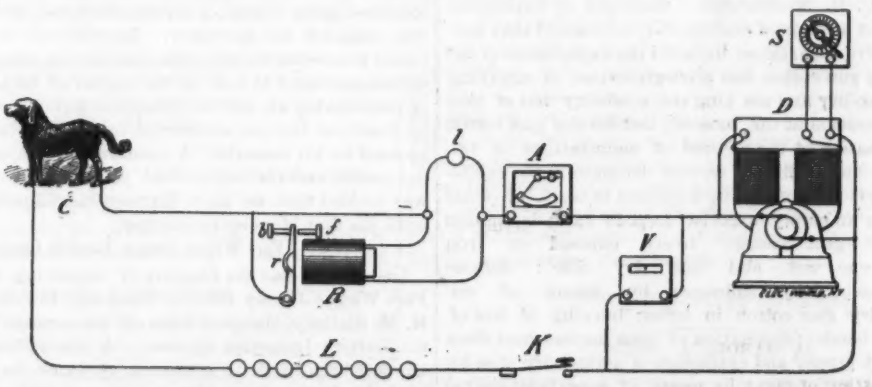



FIG. 2.—EXPERIMENTS WITH ELECTRIC CURRENTS ON DOGS.

Dog No. 7. Yellowish-brown bitch. Strong and in good condition. Weight, 41½ pounds; height, 21 inches; length from tip of nose to base of tail, 37 inches.

Resistance, 14,000 ohms. Cardew voltmeter before closing circuit on dog stood at 380 degrees, indicating 250 volts E. M. F. Contact closed for 5 seconds at 9:25 P. M., July 25, 1888. Dog uttered no sound; no struggling; died almost instantly. No struggles after current was off beyond muscular twitching.

*Twenty-second Experiment.*

Same dynamo, converter and speed.

Dog No. 8, fox-hound, strong and vigorous; weight, 56 pounds; height, 23 inches; length, 45 inches; resistance, 27,500 ohms. Cardew voltmeter, before closing contact with dog, stood at 70 degrees, indicating 181 volts E. M. F. Contact closed for five seconds at 9:50 A. M., July 24, 1888. Voltmeter dropped to 55 degrees, indicating 160 volts.

Dog motionless and silent during contact. As soon as circuit was broken all the muscles gradually relaxed, and the dog sank down dead without a struggle.

*Twenty-third Experiment.*

Same dynamo, converter and speed.

Dog No. 9, red setter. Very large and strong. Weight, 59 pounds; height, 24 inches; length, 39 inches.

Resistance, 5,000 ohms. Voltmeter before closing contact stood at 110 degrees, indicating 110 volts. Contact closed for five seconds at 10:53 P. M. same night. Voltmeter dropped to 82 degrees, indicating 99 volts.

Dog yelped once during shock, but very slightly; when circuit was opened dropped slowly to bottom of box, howled and struggled. Recovered very slowly and rose in about thirty seconds after circuit was opened.

*Twenty-fourth Experiment.*

Same dog.

Voltmeter at 50 degrees or 150 volts before closing. Contact closed for five seconds at 10:22 same night. Voltmeter dropped to 32 degrees, or 114 volts.

Dog silent and motionless during contact, but howled and struggled very violently after circuit was opened, succeeding in getting out of box.

*Twenty-fifth Experiment.*

Same dog.

Voltmeter at 68 degrees before closing, or 190 volts. Circuit closed for five seconds at 10:30 P. M. Voltmeter dropped to 48 degrees, or 146 volts.

Dog silent during shock; howled afterwards, but very weak; evidently severely injured; dropped and did not rise again.

*Twenty-sixth Experiment.*

Same dog.

Voltmeter at 85 degrees before closing, or 204 volts. Contact closed for five seconds at 10:32 P. M. same night. Voltmeter dropped to 62 degrees, or 176 volts.

Dog silent when current was on; howled feebly afterward. Dog panting violently and perspiring copiously. Evidently dying, but to put him out of pain it was decided to give higher voltage.

*Twenty-seventh Experiment.*

Same dog.

Voltmeter at 66 degrees before closing, or 260 volts. Contact closed for five seconds at 10:36 P.M. same night. Voltmeter dropped to 40 degrees, or 188 volts.

Dog died without noise or struggle.

# Special Correspondence.

## NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
168-177 POTTER BUILDING, NEW YORK, Aug. 6, 1888.

**Water in the Conduits.**

Evidence as to some of the disadvantages of the conduit was presented to me very forcibly one day last week, Friday morning, to be particular, when as I strolled down Broadway, I saw two men at Bleecker street busily engaged in drawing water at a manhole with the aid of buckets. A little surprised at this, I inquired into the matter, and elicited the interesting information that a "water pipe had burst over the conduit somewhere." I could not quite see the relevancy of the explanation, as the conduits ought to be water tight, no matter what outside pipes burst or leak. But here was a conduit as wet as a sea bath, with the water pouring into the manhole as fast as the men could get it out. If this goes on, the subways had better be made a section of the new aqueduct system.

**The Isolated Accumulator Company.**

This company, of 18 Cortlandt street, since their successful installation on Mr. Slater's steam yacht "Sagamore," have been in receipt of numerous requests from yacht owners for similar plants. It is clear that yachtsmen have come to the conclusion that the accumulator is a very useful adjunct on shipboard, as it enables them to get plenty of light while on a cruise and even when at anchor or in dock or such other time as they may not happen to have steam up.

**New York Safety Engines.**

Mr. E. T. Copeland reports a continued and active demand for the New York Safety Steam Power Company's engines, which have now been on the market over twenty years, and which have been installed in hundreds of electric lighting plants throughout the country. I was greatly impressed with the stability of the engines when an engineer called at the offices at 30 Cortlandt street, for a duplicate crank shaft for a Safety engine that had been in use 17 years steadily. He took the shaft away with him and put it in himself, showing with what ease repairs and renewals could be made. An interesting installation with Safety engines is that made at 187 Broadway, where they have been put in to run the lighting dynamo and circuit generators for the Postal tele graph plant.

**Phœnix Glass Company.**

The Phœnix Glass Company, of 729 Broadway, have recently been increasing their facilities at Water Cure, Pa., where an extensive new building has been put up with additional furnaces, etc., to be devoted exclusively to the manufacture of electric light globes, shades, battery cells and accumulator jars in all sizes. Natural gas is used in all the departments of the factory, with excellent results, and the company is always advancing in reputation for its product in decorative glass of all kinds for lighting purposes. Those who have been reading the accounts of the "moth storms" in Pennsylvania, where the electric lights have been smothered in mountains of moths blown in from the South, will realize that there is some connection between the electric light and winged insects. At first, on seeing a beautiful collection of butterflies and insects in the office of Mr. A. H. Patterson, the general manager of the company, I imagined he had, perhaps, secured his treasures in this way. I ascertained, however, that the two groups, than which I never saw anything more lovely for variety of tint and form, had been secured in Brazil by a friend of Mr. Patterson, who now proposes to dispose of them for him.

**A Disastrous Storm.**

The tremendous thunderstorm that visited this city on Saturday night, Aug. 4, will long be remembered for its damage. It is no exaggeration to say that before it was over, fires caused

by it were blazing in every direction. In Hoboken, mills and houses were destroyed to the tune of $150,000. The ferry house at St. George's, Staten Island, was set on fire. Two tenement houses at Hackensack, N. J., were completely destroyed. Over on Long Island, several fires could be seen at one time, and one of them on a farm at Bowery Bay cost $10,000. In New York, the times were lively. The Equitable Building was struck. The Western Union operating room was twice visited by "balls of light," which, coming in by the switch-board, gave the night force anxiety till they retired to earth. The ocean cable and general telegraph lines were all somewhat interfered with, as well as those of the telephone. But the worst trouble fell upon the local United States Company, whose station at East Twenty-ninth street, probably by lightning coming in from some of the circuits, was set on fire and injured, the damage reaching, it is said, not less than $10,000. The Mount Vernon, N. Y., station dynamos were also burned out. Altogether, it was a very unusual and costly storm.

### Insulated Wires.

The India Rubber and Gutta Percha Insulating Company, 159 Front street, has made a very fine seven stranded conductor for the wiring on the new cruiser "Yorktown's" Edison plant, and combining all the good qualities of the conductors previously made by them for the cruisers "Chicago" and "Trenton." The core is first thoroughly braided. Over this is run pure Para rubber, vulcanized. Then comes another coat of rubber, sulphur free. Topping this is a coat of compound. This is then taped and finished, and the whole makes one of the best insulated wires I have ever had the pleasure of examining. Cruiser work, as the contractors would probably admit, is no joke, but I think this wire will meet the case. It will be remembered that this company makes a specialty of wires and cables for resisting acids, sea air, etc., and that its general manager is Mr. W. M. Habirshaw, a fellow of the Chemical Society, of London, whose experience has given him a great familiarity with all the difficult conditions that are to be met.

### Police Patrol Systems.

It appears that my last note about the police patrol system requires amplification. The *City Record* states that the proposed contract has been reported back to the Board of Police Commissioners, not only for hearing complaints, etc., but "with a request that they arrange for a full and open competition, after due advertising and notification, by and between all the parties desirous of supplying the City of New York with a system of electrical signaling."

### A Subway Test-Case.

Mr. John A. Hesse, superintendent of construction of the Ball Electric Light Company, was arraigned on Aug. 4 before Justice Power at the Jefferson Market Police Court, on complaint of Dr. Schuyler S. Wheeler, the electrical expert of the Board of Electrical Control, that he had caused a new wire to be stretched from the northeast to the southwest corner of Broadway and Thirty-sixth street in violation of the law. Hesse pleaded not guilty and was held in $300 for trial in the Court of General Sessions. This is the first case of the kind that has been set down for trial in a court of record, and it is desired to make it a test case. W. T. H.

## NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
178 Devonshire Street, Boston, Aug. 6, 1888.

### Personals.

Mr. C. D. Smith, Eastern agent of the National Carbon Company, of Cleveland, O., was in this city last week and was a guest at the rooms of the Boston Electric Club.

Mr. H. A. Buck, formerly engaged in actively pushing the Berryman heater interests in this section, has accepted a position with the Wainwright Manufacturing Company as manager of the company's Boston office, and will have charge of the New England business.

Mr. J. Frank Perry, superintendent of the Lynn, Mass., Electric Lighting Company, accompanied by Mr. E. J. Richards, of the Thomson-Houston Electric Company, visited this office on Wednesday, Aug. 1.

Mr. E. B. Swadkins, the superintendent of the Milford (Mass.) Electric Light and Power Company, was among the visitors at the Boston Electric Club last week, a guest of Mr. Wm. E. Stow, of electric motor fame.

Mr. Chas. Jacobs, the traveling agent of the Wainwright Manufacturing Company, of Medford, Mass., was my companion part of the way while en route on my trip in Western New England. Mr. Jacobs was "business bent" to affect several sales of Wainwright feed water heaters.

### Dissolution of Partnership.

The firm of Reed & Page, dealers in electrical supplies and furnishers of electrical fittings of every kind, has been dissolved by mutual consent. The business will be continued under the name of Chas. H. Page & Co., at the same place.

### A Big Water-Power Plant.

One of the most important manufacturing enterprises of the season is the immense wood pulp mill, now being erected at Piscataquis Falls, Me., by the Piscataquis Falls Pulp and Paper Company, a new corporation of which Eugene H. Clapp is president, and S. L. Montague is treasurer. Both of these gentlemen are well known citizens of Boston. This company is developing a splendid water-power, having 22 feet fall, which will be utilized for driving the mill. The motive power will consist of eleven (11) pair of 30 inch and one pair of 35 inch horizontal Victor turbines, making 24 wheels, which they have ordered of the Stillwell & Bierce Manufacturing Company, Dayton O. These wheels will develop nearly 3,500 horse-power, all of which will be used, and it is probably the largest order for water wheels ever placed at one time in this country. These Victor turbines have obtained great celebrity, and are in demand among the most discriminating consumers of water-power.

### An Enterprising Firm.

Messrs. Charles H. Page & Co., successors of Reed & Page, electricians, of Worcester, Mass., have the contract to put in all the electrical apparatus in the Lamb building, on Pleasant street, the H. H. Houghton building, corner Park and Salem streets, and the new building of Wm. H. Bliss, on Lincoln street, all in process of construction. They have recently fitted the new Pilgrim Church and the Salem Street Church with electric gas-lighting apparatus.

### An Advance Trumpeter to Clam-Bake.

It is rumored that a plan has been already perfected by some friends of Mr. Eugene Phillips to charter a large steamboat in New York on Friday afternoon, Aug. 31 (after the adjournment of the Electric Light convention), and with a large number of the members of the Electric Light Association, namely, those specially invited to the annual clam-bake, to sail through Long Island Sound to Providence. The following day (Sept. 1) will be devoted to the hospitality of Mr. Eugene Phillips, president of the American Electrical Works, at the bake, which will take place at some picturesque spot on Providence Bay. Mr. Phillips is determined to make his clam-bake of 1888 the most successful and highly entertaining of all.

### The West End Electric Railroad.

At a meeting of the Boston Board of Aldermen on July 30, a petition was received from the West End Street Railway Company, for leave to establish and maintain the electric system of motive power in the operation of its cars, and to erect and maintain poles and wires for the overhead system, beginning at Oak square, Brighton district, running thence on Washington, Cambridge, Harvard avenue, Beacon street, near St. Mary's, to West Chester Park, to Boylston street, thence about 100 feet west to Exeter street on Boylston street; also for leave to establish, maintain and use, from said point on Boylston street, the conduit system, so called, and to make the necessary underground and surface alterations therefor from the point about 100 feet westerly of Exeter street to Park square. The petition was referred to the committee on railroads.

### Another Electric Railway.

Advices from South Framingham, Mass., dated July 30, state that the Union Street Railroad had a hearing on that date before the Selectmen, and asked permission to use electricity as a motive power on its cars between South Framingham and Saxonville, Mass.

### The Thomson-Houston System at Southbridge.

An isolated arc plant of 150 lights has just been installed by the Thomson-Houston Electric Company at the American Optical Works, Southbridge, Mass. The installation was made under the direct supervision of Mr. T. T. Robinson.

### The Jarvis Engineering Company.

This active and prosperous company has received an order from the Dover, N. H., Electric Light Company for another horizontal tubular boiler, set with the Jarvis patent furnace. This boiler will be of 150 h. p. Among the other sales made by the Jarvis Company recently are the following: A 60 h. p. Armington & Sims engine to the Taunton, Mass., Electric Company, and a 125 h. p. engine of same make for use in the isolated electric light plant in one of the factories of the Boston Rubber Shoe Company. President Jarvis, of the company, is at present at Syracuse, N. Y., where he is personally superintending the erection of a steam plant for the street railway company of that city, which will, when complete, be equipped with two Armington & Sims engines of 80 h. p., and two large horizontal tubular boilers etc., etc.

### Electric Lights at Milford.

The Milford, Mass., Electric Light and Power Company has finished the installation, and is now satisfactorily running, the first Thomson-Houston "three wire compensating" system in New England. This system was installed for the Milford Company under the supervision of experts from the Thomson-Houston factory. Three hundred lights are now in use. Superintendent Swadkins reports that his customers are well pleased with the lights.

### Torpedo Practice at Newport.

The graduating class of the Torpedo School at Newport, R. I., had its first day's practical exercise at the torpedo station, Monday, July 30, before a board of visitors, and showed a marked proficiency on the part of the officers. The board consisted of Capt. O. E. Matthews, Commander F. J. Higginson and Lieutenant Commander C. H. Stockbridge. Exercises in explosives, fuses, electricity and high speed engines were performed that day. Those in the explosive department included the explanation of the processes of making gun cotton and nitro-glycerine; of applying the heat test for stability and making the solubility test of gun cotton; the demonstration of the monthly test for dry gun cotton primers; the explanation of the method of manufacture of fulminate of mercury, and of filling service detonators; the exhibition of power of service detonator by explosion of block of wood and can of water in an empty exercise torpedo case; detonation of disc of dry gun cotton, freely exposed on iron plate, and of one wet and one dry disc; demonstration of explosion by influence by means of six half inch discs of dry gun cotton in series; burning of box of wet gun cotton on bonfire; detonation of some unconsumed discs on iron plate by dry primer and extinction of ignited dry disc by means of water; cutting of plank by means of superficial charge of gun cotton, and detonation of dynamite cartridge by Bickford fuse and blasting cap. The exercises in fuses included explanations of the manufacture and action of service detonators; of the manufacture of service igniter and of faults apt to occur in detonators. In electricity six incandescent lights were wired up, tested and operated. The insulation of incandescent light at the station was described. Two push-buttons, two electric bells, a battery and wire were connected so that each button rung a bell at either end of the wire, and also both bells. The service automatic lamp was operated from a Gramme dynamo. The Brush automatic lamps were operated from the same, and a service search light was operated by means of hand lamps, Mangin projector, Brotherhood engine and Gramme dynamo. The last exercise was a description of the Westinghouse, Armington and Sims, Brotherhood and Herreshoff high speed engines. The exercises of the torpedo class before the board of visitors continued in the evening and included operation of search lights, bell circuits, currents and other electrical manœuvres.

### American Electrical Works.

An order has just been received at this widely-known wire manufactory for upward of thirty miles of Faraday cable. This cable is gaining steadily in popularity throughout the country, and as its merits become more generally known it will find a very large sale. This cable has an insulation of superior quality, and it possesses a remarkably low inductive capacity. The American Electrical Works Company make a specialty of drawing and covering fine magnet wire, and this department is constantly taxed to its utmost facilities to keep pace with the orders. Electric light wire of every size, and in all styles of insulation, is made in large quantity at these works, and the annunciator wire for which the company has a widespread reputation has found favor with every one who has used it, and its sale is steadily increasing.

### Gas and Electric Light Consolidation.

The stockholders of the Lynn, Mass., Gas Company and the Lynn Electric Light and Power Company held a joint meeting at the works of the former on Thursday, Aug. 2, and an unanimous vote was made to consolidate the two interests.

### Newport Lectures.

The torpedo school at Newport has just been favored with two excellent lectures. One was delivered by Mr. Wm. Maver, Jr., on all the modern developments of telegraphy, and was at once full, clear and complete. The other was by Mr. F. J. Sprague, himself an old navy officer, who gave an interesting lecture on electric motors, and instanced a number of uses to which such motors would be put on board men-of-war, such as training guns, controlling the rudder, raising ashes or ammunition, lowering stores, etc.

### Thomson-Houston Plants.

The Thomson-Houston Electric Company reports the following increases: Bridgeport, Ct., 800 incandescents; Augusta, Ga., 500 incandescents, 100 arc; Morgan Eng. Co., Alliance, O., 400 incandescents, 35 arc; Buffalo, N. Y., 50 arc; Columbus, O., 85 arc; Owego, N. Y., 30 arc; Northam Co., Phila. Pa., 50 arc; Johnstown, N. Y., 60 arc; So. Framingham, Mass., 30 arc; H. Balleman, Brooklyn, N. Y., 30 arc; Malden, Mass., 500 incandescents, 5 arc. Also the following new arc installations: Hoosac Falls, N. Y., 60; Knoxville, Tenn., 50; Pensacola, Fla., 50; Macon, Ga., 35; White Plains, N. Y., 30; Penn Bluff, Ark., 70; Pittston, Pa., 35. W. I. B.

## WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
44 Lakeside Building, Chicago, Aug. 4, 1888.

### A New Electric Light Company.

An incorporation license was granted this week by the Secretary of State to the South Side Electric Light and Power Company of Chicago, capital stock $500,000; incorporators, H. V. Harris, James Hood and Frank Butterworth.

### Personal.

Mr. C. Kerr, of the firm of Westinghouse, Church, Kerr & Co., of New York, is spending several days of his summer vacation with his brother in Chicago. Mr. Kerr, with his family, have been spending a considerable portion of the summer in the Northwest.

### Some Large Switches.

Sixty-six 400 ampère and sixteen 800 ampère switches are being made by Messrs. J. Lang & Co., 44 Michigan street, Chicago, for the Frank S. Marr Construction Company, of Pittsburgh, for use in the new Edison electric light and power plant on Adams street, where they will soon be placed in position. These switches, some of which are the largest ever constructed of that pattern, are of novel design, and are the invention of Mr. W. S. Andrews, superintendent for F. S. Marr, who is so well known among electricians. The company are also very busy on the new patent gas attachment, which, by the way, is also the invention of Mr. Andrews, feeder plug switches and safety catch holders, and many other electric light supplies.

### The Chicago Electric Club.

A meeting of the Board of Managers and officers of the club was held at the rooms of the club, July 30. Mr. S. A. Barton, recently elected president of the club, was in the chair. The treasurer being absent, a report which had been prepared by him was read by the secretary. The question of moving the club rooms to a better location was discussed at some length and a committee appointed to look up the matter of location. The matter of establishing an electric trusteeship for the club was proposed by President Barton, and considerable enthusiasm was apparently aroused by his remarks. A committee was appointed to look into the matter and formulate some plan of action. Upon motion it was decided that no more literary meetings of the club be held until the first Monday in October.

### Fort Wayne Jenney Electric Company.

Last week I had the pleasure of inspecting the factory of the Fort Wayne Jenney Electric Company, in company with Mr. M. M. M. Slattery, the electrician of the company, and inventor of the Slattery Induction System. A new addition to the factory has just been made of a three story brick building, 120 feet by 65 feet. In the alternating department 300 people are now employed, which number is being constantly increased. Within the past eleven months, under the efficient direction of Mr. Slattery, the various manufacturing departments have been entirely reorganized, and the company are to be congratulated upon the appearance of the factory, and the amount of business which they have at the present time on hand. The factory is now thoroughly organized for making everything in the way of electric light apparatus. In the arc department, which is under the superintendence of Mr. Charles Hilton, the company will soon be prepared to furnish a 10 ampère arc light as well as their former 18 ampère arc. The company are at present constructing at Plymouth, Ind., some 50 miles from Fort Wayne, a large new factory for the arc business. The company will remove this department to the new factory as soon as completed, and they are confident that the new location will give them many advantages over the old one. In the alternating department everything is fully equipped for the manufacture of the system. The company has already turned out from it twenty-five 1,000 light dynamos and two 2,000 light dynamos, with their corresponding converter appliances. The capacity of this department, which by the way is at present taxed to its maximum, is 3,600 lights per week, and three 1,000 light alternating dynamos per day. Mr. Slattery in-

forms me that their facilities are being increased as fast as possible, and they soon hope to double their capacity. In Mr. Slattery's private workshop I saw in actual operation an alternating current motor, which is the first time it has been my fortune to see. This is the first one produced by Mr. Slatttry and is the result of much study and experiment on his part. The patents have not yet been issued, and I cannot, at this time, go into the details of its construction. The weight of the motor is 110 pounds and it has a maximum capacity of about 2 h. p., making 2,000 revolutions per minute. From actual tests Mr. Slattery informs me that he has secured 85 per cent. efficiency, and he expects to get an even increased output from it. From the same weight and type of motor he expects to get an efficiency of 3½ h. p. Not the least sparking was visible, yet the current was alternating in polarity and it was directly connected with the converter. Mr. Slattery is fixing to place in operation several motors throughout the factory, which will be used in running machinery, ventilating fans, etc., where they can be seen in actual service.

### Hymeneal.

The marriage of Mr. Geo. Cutter, of the Thomson-Houston Company, is announced to occur on Aug. 29. Mr. Cutter is well-known among electricians as a young man of much promise, having been engaged with the Thomson-Houston Company for a number of years. Upon this new step his many friends join in congratulations and in wishing him complete happiness. Mr. and Mrs. Cutter will make a trip of some days in northern Wisconsin and the Northwest, at the end of which time they will return to Chicago, where they will make their home. Mr. Cutter's ability has already won recognition throughout the great West, and he is in the front rank as an electrical engineer.

### The Electrical Construction Company.

The Electrical Construction Company report a large number of recent contracts for house work. The sale of specialties manufactured by the company is also brisk. They have just put in for the Kirby-Carpenter Company, of Menominee, Mich., a very large watchman's clock for service in their extensive lumber yards.

### A New Electric Road for Des Moines, Ia.

The Broad Gauge Street Railway, of Des Moines, Ia., has just given a contract to the Thomson-Houston Electric Company to put in operation an electric road of the Thomson-Houston system, to be seven miles in length and require eight cars to start with. An exclusive franchise for ten years has been given the company. The maximum grade is about 7 per cent. The overhead under-contact system will be used. The Thomson-Houston Company have also received orders during the past week for 360 arc lights and over 3,000 incandescent.

### Personal.

Mr. G. A. McKinlock, treasurer of the Central Electric Company, left this week for a trip of a week or ten days through the East. New York and Boston are points which will be visited by Mr. McKinlock before his return.

### The Alternating System.

The local Brush Electric Light Company, of New York, recently ordered four 1,000 alternating current dynamos of the Fort Wayne Jenney Company. The dynamos were shipped this week from the factory.

### Dynamo Oil Cups.

The Bennett Manufacturing Company of Chicago, manufacturers of the Bennett sight feed lubricator, oil cups, etc., are out with a new oil cup, especially adapted for use on dynamos and high speed engine eccentrics. The goods are handsomely finished and are of neat design. They also especially recommend their sight feed lubricator for high speed engines, as it is quick to act.

### Telephone Quotations.

Col. S. G. Lynch, broker, 146 La Salle street, furnishes quotations upon telephone stock as follows:

| | | | | | |
|---|---|---|---|---|---|
| Bell of Mo..... | $150@ | $155 | Iowa Union..... | $27@ | $28 |
| Central Union..... | 47@ | 48 | Michigan..... | 79@ | 80 |
| Chicago..... | 350@ | 375 | Missouri and Kansas | 70@ | 71 |
| Colorado..... | 19@ | 21 | Rocky Mountain Bell | 40@ | 45 |
| Cumberland..... | 65@ | 68 | Wisconsin..... | 110@ | 112 |
| Great Southern... | 35@ | 40 | | E. L. P. | |

## ENGLISH NOTES.

LONDON, July 25, 1888.

### The Edison-Swan Case.

The Edison-Swan Company has given notice of its intention to appeal against the decision of Mr. Justice Kay in the recent trial.

### Messrs. Crompton & Co.'s Works.

Some few days ago I had the opportunity of paying a visit to the well-known electrical engineering works of Messrs. R. E. Crompton & Co., at Chelmsford, in company with a large contingent of engineers and journalists. The largest armature ever built has just been turned out by this firm, and has recently gone down to Milton to work the Cowles process. Amongst several other interesting machines I particularly noticed the new Crompton-Swinburne alternator. The armature consists of a number of thin iron discs strung on a centre spindle. The discs are clamped together and the coils dropped into transverse slots; the whole armature is then wound round with a layer of iron wire. This machine is expected to have an output of 2,000 volts and 32 ampères at 400 revolutions, or about eight times the output of a Westinghouse machine of the same size. The large switch-board destined for the Whitehall Court central station, and which will deal with some 10,000 ampères, naturally attracted great attention. To measure the current Mr. Crompton has devised a somewhat peculiar arrangement. In each circuit a large 12-inch platinoid bar is introduced. The ends of any bars can be joined to the terminals of a Deprez-d'Arsonval galvanometer, which actually takes, therefore, but a small proportion of the main current; as, however, the resistances of both the instrument and the platinoid shunts are practically constant, the same table of values does for all the circuits. In the yards a model of an electric training gear was shown, which has been applied by Messrs. Crompton & Co. to a 38-ton gun for the government. A new brush, made of fine wire gauze, is used for this machine, and is found to answer very well indeed. The works were full of interest throughout, and the expedition was a pronounced success.

### Electrical Traction in Paris.

I have recently heard from Paris that an important scheme has been laid before the Municipal Council for an underground railway, running from the Bois de Boulogne to the Bois de Vincennes, a distance of about 8 miles. The route traversed is by the Champs Elysées, the Rue St. Honoré and the Gare de Lyon. The proposal is to excavate the tunnel without opening the surface of the ground, except at certain stated points. The tunnel will literally be an iron tube 19 feet in diameter. The line will be worked by electricity, the current being taken off from a central rail. It is intended to establish a two-minutes service, and to maintain a maximum speed of 12½ miles an hour. The estimated cost of the whole scheme is 36,000,000 francs, of which 22,000,000 are provided for the construction of the tunnel and the permanent way. If the concession is granted before Oct. 1 the authors of the project guarantee to complete the section between the Bois de Boulogne and the Place de la Concorde by the 1st of July, 1889, and also to extend a branch to the exhibition buildings. So far as I can judge from the details available, it appears to me that the scheme has been well thought out and is one that should command success. On the other hand, it is quite sure to meet with a strong opposition in the Municipal Council, and I much fear that the chance of its becoming a *fait accompli* is very slender.

### Bath.

The corporation of Bath, having recently advertised for tenders for lighting the streets with arc lamps, had before them last week the results of tenders received. The price per lamp ranged from £19 17s. 6d. per annum for 1,200 c. p., tendered by a local firm, up to £30 18s. 4d. per lamp of 2,000 c. p., tendered by a London firm. It is to be feared that if the local firm obtains the the contract they will find they have made a bad bargain. No decision has yet been arrived at.

### Dublin.

The corporation of Dublin also had the subject of electric lighting before them this week, and passed a resolution accepting the terms of the Provisional Order which has been drawn up by the Board of Trade. The banks of the Liffey are therefore likely to reflect the beams of the electric light, while those of the Thames are still shrouded in gloom.

### The Exchange Telegraph Company.

The Exchange Telegraph Company, which supplies most of the clubs and leading hotels in London with a tape service, has recently made some improvements in the instruments, by which the speed of working will be nearly doubled. The instruments employed by this company print by Roman type. The type wheel is driven by clockwork, and the current raises the tape and presses it against the wheel at the moment when the letter required to be printed is passing. Several hundred instruments are worked in parallel from one transmitter through a system of relays. This principle of course involves absolute synchronism, which is obtained by a method which I will not stay to describe as it is not novel. The recent improvements consist: 1st, in the adoption of aluminum instead of steel for the working parts, and, 2d, in an extremely ingenious mechanical device whereby the action of the current is made to assist instead of retarding the motion of the clockwork, and without disturbing the synchronism. The result of this very clever combination, which is due to Mr. Higgins, is seen in the fact that the speed of working has now attained no less than 40 words per minute, involving upon an average as many as 100 reversals of current per second. Copper wires are exclusively used for the line, and the electro-magnets are of such construction as to obtain minimum self-induction.

### Atlantic Telegraph Rates.

At the half-yearly meeting of the Direct United States Cable Company, which took place on Friday last, Sir John Pender said the company was not in a position at all creditable to business men. They had given the sixpenny rate a fair and full trial for two years, and it had not proved remunerative. However, negotiations were now going on between the competing companies, and on Aug. 15 they might expect to be working at 11d. instead of 6d. It is probable, therefore, that we are at the end of this ruinous competition, which has been very detrimental to the prospects of the cable companies without the public obtaining a corresponding benefit. As the Mackay-Bennett Company does not join the pool, but only agrees to the rate it has always contended for, there is no danger of the public having to again pay the old tariff.

## THE TELEGRAPH.

**Little Rock, Ark.**, is to have a fire-alarm system operated by a local company.

**Government Telegraphs** are the particular desire of the Boston Knights of Labor.

**T. M. B. A.**—Assessment No. 220 for $1 has been made to meet the death claims of W. F. Ferguson, S. B. Morse and J. O'Connor. The certificate of the first named was issued as late as June, 1887. He was 32 years old.

**The Cable Agreement** has been signed between the pool and the Commercial Cable Company to regulate the price to 25 cents a word to Europe, commencing September 1. The rate is now 12 cents a word, and prior to the cutting was 60 cents.

## THE TELEPHONE.

**Erie Telephone.**—The Erie Company has declared a dividend of ¾ per cent.

**Elkhart, Ind.**—The Indiana Telephone Company, of Elkhart, has been incorporated by W. Hornberger and others with a capital stock of $60,000.

## THE ELECTRIC LIGHT.

**Baton Rouge, La.**—Mr. J. H. Andrews is negotiating to put in a plant.

**Truckville, Pa.**, and Mahanoy Plane will probably go in for electric lighting.

**Yazoo City, Miss.**, has contracted for ten Thomson-Houston lights on its streets.

**Manchester, N. H.**—The bids on city lighting are for 240 lights for three years.

**Rhode Island.**—Electric lighting is proposed for Phenix Lippit and River Point.

**Mount Holly, N. J.**, is to have an electric lighting plant operated by a local company.

**Clifton, S. C.**—The Clifton Cotton Mill Company are to put in an incandescent plant of 600 lights.

**New Orleans, La.**—Work is already begun for the reconstruction of the Brush-Westinghouse plant.

**Providence, R. I.**—The Narragansett Electric Light Company is to build a brick station costing $30,000.

**Fort Smith, Ark.**—An Edison incandescent plant has been contracted for by Mr. G. Tilles for the opera house.

**Virginia, Cal.**—The Virginia and Gold Hill Electric Light Company has been formed by W. E. Sell and others.

**Hackensack, N. J.**—The Hackensack Electric Light Company has been formed with a capital stock of $25,000.

**Findlay, O.**—The Thomson-Houston Company, at Findlay, has taken a city contract for 100 lights, at $6,000 a year.

**Merced, Cal.**—The Merced Electric Light Company has been incorporated by W. E. Dean, D. C. Bates and others, with a capital stock of $100,000.

**David's Island, N. Y.**—Bids are wanted for lighting the new barracks at David's Island, and can be filed with the Quartermaster until Aug. 14.

**Natchez, Miss.**—The Citizens' Electric Light Company has been organized by C. T. Chamberlain, J. A. Dicks, and others, to put in a Van Depoele plant.

**Red Wing, Minn.**—The Red Wing Electric Light and Power Company has been formed by S. D. Lawther and others, with a capital stock of $50,000.

**Cartersville, Ga.**—The Cartersville Improvement, Gas and Water Company, to put in an electric light plant, &c., has been organized by G. W. Chipman, of Boston, Mass., and others.

**Parkersburg, W. Va.**, is lighted by the Fort Wayne Jenney arc system, and the local *Journal* invites everybody "to come and see the best lighted city in the Ohio Valley."

**Mine Lighting.**—Clark Bros., of Belmont, N. Y., have installed a Mayo incandescent plant in the Pancoast Coal Company's mine at Throop, Lackawanna County, Pa. The plant has now been in satisfactory operation for more than a month.

**Rockford, Ill.**—Messrs. Emerson & Talcott having become largely interested in the Forest City Electric Light Company, of Rockford, Ill., the plant will be enlarged and moved across the river, where they will utilize, as far as possible, water power.

**New York City.**—The Manhattan Electric Light Company, 59 West Fifty-sixth street, New York city, will erect on the corner of Eightieth street and Avenue B a three-story brick 53 × 123 factory, to cost $75,000; also two-story addition 34 × 123, to cost $25,000.

**Ball Engines.**—Recent orders for Ball engines for electric lighting have been received from Moses Jay, Jr., Petersburg, Va.; Newark, N. J., Schuyler Electric Light Company, third order, and the Mount Morris Electric Light Company, second order, by C. R. Vincent & Co., the New York agents.

**Trainyard Lighting.**—An editorial note was published in this paper recently on the highly successful and economical lighting of the Southern Pacific trainyard at Oakland, Cal., by incandescent lights. It should be mentioned that the plant is of the Brush system, a special installation having been made by the California Electric Light Company, which has long enjoyed a large business as Brush agent in California, etc., and which has already sold hundreds of thousands of dollars of Brush apparatus this year. The trainyard plant in question has attracted great notice from railroad men, and numerous installations of the same kind may be expected.

## APPLICATIONS OF POWER.

**Salem, Mass.**—A successful start has been made on the Naumkeag electric road.

**Roanoke, Va.**—The road of the Roanoke Street Railroad Company is to be operated by electricity.

**Lowell, Mass.**—The Middlesex Electric Light Company is to run a special day circuit for constant current motors.

**Binghamton, N. Y.**—The Thomson-Houston Company has orders for additional plant from the electric railway at Binghamton.

**Sandusky, O.**—The Sprague Company are still adding to their already long list of roads. The last contract is to equip the Sandusky, Ohio, Street Railway.

**Pittsburgh, Pa.**—Another steel bridge will be built, it is stated, across the Allegheny River, in Pittsburgh, for the electric lines of cars. The capital to be invested is $500,000.

**Chicago.**—Mr. B. E. Sunny, president of the Chicago Arc Light and Power Company, reports himself as very well pleased with the thirty Baxter motors now running on the company's circuits.

**San Diego, Cal.**—Mr. George D. Copeland, President of the Electric Rapid Transit Street Car Company of San Diego, has applied to the city council for permission to erect poles for a plant of the Westinghouse electric lighting system.

**Marion, Ind.**—The city council at Marion has granted an ordinance for a storage street railway, open to any one desiring within a limited time, to accept the opportunity. Natural gas may be had by simply boring a well for it. The well would cost about $2,000, making fuel practically free.

**Huntington, W. Va.**—The Huntington Electric Light and Street Railway Company, Huntington, W. Va., J. C. Caldwell, secretary and treasurer, want to purchase an engine and boiler, automatic, from 75 to 125 horse-power, with all the latest improvements, for running electric machinery for their electric street railway; must be nearly as good as new. Terms cash when the machinery is delivered f. o. b.—*Mfrs'. Record.*

## PERSONALS.

**Dr. H. N. Allen,** secretary of the Corean Legation to the United States, has been in New York to make arrangements for direct telegraphic communication between the two countries.

**Mr. A. A. Knudson,** who has been so successful in reorganizing telephone matters in Nova Scotia, has returned home to Brooklyn for a brief vacation. He now has a large New Brunswick enterprise, of similar nature, in hand, and returns to St. John to carry it through.

**Mr. E. H. Johnson,** president of the Edison Electric Light Company, has just returned from a successful business trip to Minneapolis. He was absent from New York less than a week, but during that time he organized a local Edison Company in Minneapolis with a capital of $500,000.

## MISCELLANEOUS NOTES.

**Montreal, Can.**—Mr. W. C. Hibbard, the electrician, has formed the Hibbard Electric and Manufacturing Company, with a capital stock of $150,000.

**The Edison Machine Works.**—Mr. Samuel Insull, the general manager of the Edison Machine Works, of Schenectady, has issued a notice stating that in spite of the fire in the foundry there, work is going on as usual, another foundry for temporary use having been secured. The old foundry is being rebuilt as quickly as possible.

## BUSINESS NOTICES.

**Jordan & Gottfried, 208 Canal Street, N. Y.,** carry a complete stock of iron and brass machine and wood screws, bolt cap and set screws, taps, dies, files, twist drills, brass and rubber tubing, rod and sheet copper, brass, German silver, steel and iron wire, shafting, tools, etc.

**The Partz Electric Battery Company,** of Philadelphia, having found their old quarters at 1,723 Chestnut street too small, have leased the large building at 636 Arch street, same city. They are now prepared to fill all orders promptly, and in addition to their large line of Open Circuit and Gravity and Motor Batteries, have a full line of small Motors and Dynamos. Send for their price list and catalogue, or write to them stating what you want.

263 FULTON STREET,
BROOKLYN, July 30, 1888.

**To Manufacturers and Users of Secondary Batteries:** Having been informed that certain notices have been published by the Doane & Wellington Manufacturing Company, and also by Otis C. Flick, in which notices contradictory statements are made calculated to confuse parties interested, I hereby notify you that *I am the sole licensee under the patents and improvements* alluded to in the notices above mentioned, and for verification of this I refer you to the records of the United States Patent Office. Yours respectfully, J. W. CARTER, JR.

# OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

### PATENTS DATED JULY 31, 1888.

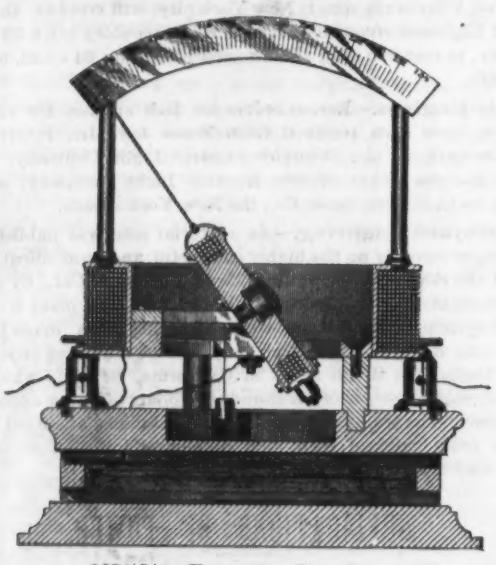
**(1) 386,814. (2) 386,815. Telautograph;** Elisha Gray, Highland Park, Ill. Application filed June 13, 1888. For description see page 64, this issue.

**386,828. Temperature Regulator;** Charles W. Johnson, Holyoke, Mass. Application filed Dec. 27, 1887. A fluid valve is operated by a weight controlled by an electro-magnet. The magnet circuit is controlled by a thermostat.

**386,860. Coin-Operated Induction Coil;** P. G. Williams and A. W. Roovers, Brooklyn, N. Y., said Roovers Assignor to said Williams. Application filed Jan. 5, 1888. By the movement of the electrodes, which are grasped by the person receiving the current, the strength of the current may be determined, and also its duration.

**(1) 386,886. (2) 386,887. Multiple Switch-Board;** Milo G. Kellogg, of Hyde Park, Ill. Applications filed respectively July 30, 1887, and Aug. 23, 1887. (1) A metallic circuit in which subscriber's line is normally disconnected from ground at the subscriber's station. The calling generator is located in this line, and a switch co-operates with a normally open ground to close the same while the generator is being operated. (2) By the use of a switch testing plug connected to one side of the test-receiving instrument, the operator, at will, may connect the test-receiving instrument, grounded on one side, to the open end of the line on the other side, and thereby determine whether the line is switched for conversation.

**(1) 386,992. (2) 386,993. Galvanometers;** Philip Lange, Pittsburg, Pa., Assignor to the Westinghouse Electric Co., of same place. Application filed respectively Oct. 29, 1887, and Jan. 21, 1888. (1) The general plan of the invention is to cause a variation or disturbance in the balance in two branches of a conductor connected across the supply conductors by means of a variation in the relative resistances caused in two different conducting bodies by the heating effects of electric currents of different electromotive forces. (2) Two independent



387,131. ELECTRIC INDICATOR.

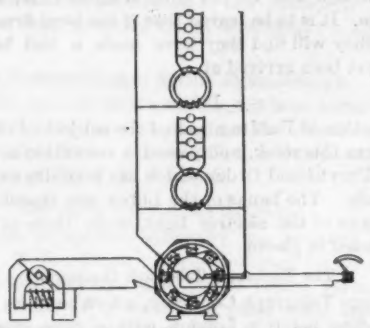
fixed coils acting in conjunction, one connected in series with the work circuit, and the other in shunt thereto, and a core movable with reference to both coils.

**386,898. Secondary Battery;** John S. Sellon, of the Hall, Sydenham, County of Kent, England, Assignor to the Electrical Accumulator Co., of New York. Application filed Sept. 28, 1887. Patented in England Nov. 10, 1886, No. 14,563. The plates of the battery are in the form of trays, placed one over the other; the overflow from one is conducted to that next below.

**386,910. Coin-Operated Electrical Apparatus;** P. Everitt, London, England. Application filed Feb. 4, 1888. The handle connected with the electric machine for generating the current serves also the purpose of completing the circuit. The handle is operated by the party receiving the shock.

**386,936. System of Electrical Distribution;** M. M. M. Slattery, of Fort Wayne, Ind., Assignor of one-half to the Fort Wayne Electric Light Company, of same place. Application filed April 5, 1888. Claim 1 is as follows: In a system of electrical distribution and in combination an alternating current dynamo and converters electrically connected with the main-line conductors in multiple arc and organized to transform the current in the main conductors into currents of less potential and greater quantity in the secondaries, each converter made with a primary coil containing such length of wire exposed to magneto-electric induction that when operated by the dynamo with which it is to be used with its secondary circuit open the electrical pressure and counter-pressure in its primary circuit shall be equal, with incandescent lamps or other translating devices in the secondary circuits. See illustration.

**(1) 386,956. (2) 386,796. (3) 386,797. Regulators for Electric Circuits;** Reginald Belfield, of Great Barrington, Mass., Assignor of (1) to the Westinghouse Electric Company, and of (2) and (3) to George Westinghouse, Jr., of Pittsburgh, Pa. Applications filed, respectively, Oct. 29, 1887; June, 29, 1886, and June 29, 1886. The inventions consist generally in connecting between two distributing conductors leading from an electric converter or generator, a coil of insulated wire provided with a movable core, of less length than the coil, and in deriving from a portion of the coil a secondary circuit, in which the lamps to be regulated are included. By

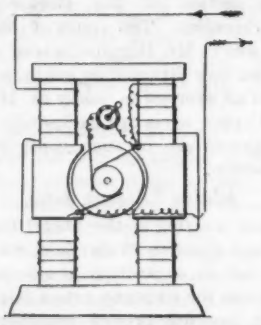


386,936. SYSTEM OF ELECTRICAL DISTRIBUTION.

varying the position of the core with reference to the position of the coil included in the secondary circuit, the brilliancy at which the lights will be operated may be varied.

**386,965. Telephone Transmitter;** Wm. R. Cole, Detroit, Mich., Assignor to himself, Frank G. Smith and George W. Moore, Trustees, of same place. Application filed May 10, 1886. One electrode is mounted in front of the diaphragm button upon a lever pivoted above the diaphragm.

**386,980. Mechanical Telephone;** A. W. Hall, New York, N. Y. Application filed Sept. 28, 1887. The line is connected at one side of the diaphragm, and runs parallel with the same for some distance. By this arrangement the sound waves impinge directly upon the line as well as upon the diaphragm.

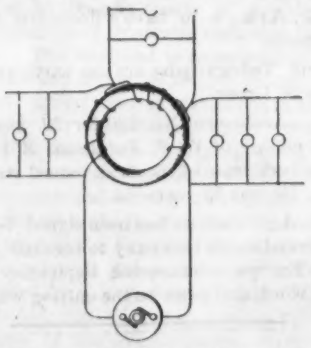


387,195. REGULATION OF ELECTRIC MOTORS.

**386,986. Electric Insulator Peg;** Wm. E. Joslin, South Scituate, R. I. Application filed Feb. 13, 1888. The neck or shank of the peg is smooth, the usual shoulder being removed.

**387,010. Brush-Holder for Electric Machines;** Albert Schmid, of Allegheny, Assignor to the Westinghouse Electric Co., of Pittsburgh, Pa. Application filed Sept. 1, 1887. A spring is arranged to be compressed between the clamp and its support, so as to exert its force in a direction oblique to the support of the clamp. Means are provided for carrying the spring into a second position upon the opposite side of the support.

**387,013. Electric Converter;** Oliver B. Shallenberger, of Rochester, and Henry M. Byllsesby, of Pittsburgh, Assignors to



387,117. APPARATUS FOR ELECTRICAL CONVERSION AND DISTRIBUTION.

the Westinghouse Electric Co., of Pittsburgh, Pa. Application filed Sept. 1, 1887. A box containing the converter, and provided with an apartment wherein connections are made between the lines and the coils.

**387,049. Battery Zinc;** Robt. B. Carr and Parker Borden, of Fall River, Mass. Application filed Dec. 27, 1887. After the body of the zinc has been cast it is placed into a mold and a zinc cap carrying the wire connection fused to it.

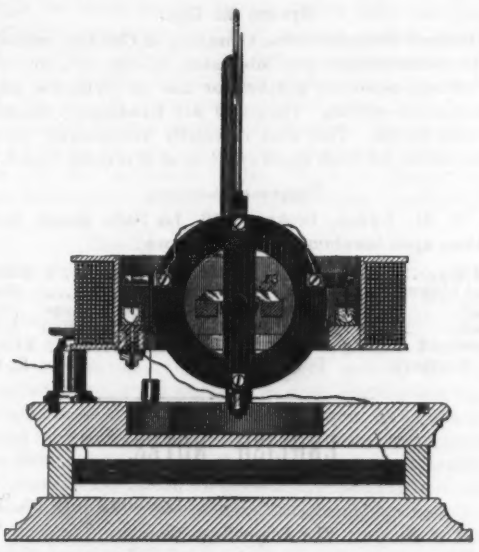
**387,051. Lightning Arrester for Electric Circuits;** F. A. Cheney, Elmira, N. Y. Application filed May 12, 1888. To prevent the continuance of an arc between the serrated plates of the arrester, one of the plates is connected eccentrically with a rotating device so that the plate is given a vibratory movement. The device is set in operation by the abnormal current acting through a magnet.

**387,117. Apparatus for Electrical Conversion and Distribution;** Wm. Stanley, Jr., of Great Barrington, Mass., Assignor to the Westinghouse Electric Co., of Pittsburgh, Pa. Application filed Feb. 28, 1887. This is a method of equalizing the distribution of potential upon two or more work-circuits, which consists, first, in creating a magnetic field common to all the work-circuits by establishing in the supply-circuit an electromotive force; second, in inducing a counter electromotive force in the supply-circuit, and, third, in supplying two or more work-circuits with composite currents formed by the impressed and counter electromotive force, whereby the excess of energy in one work-circuit is transferred to another by means of the the magnetic field. See Illustration.

**387,123. Flue for Electric Transformers;** Elihu Thomson, Lynn, Mass. Application filed June 9, 1888. The converter is placed in a closed chamber, with a flue connecting to the outer atmosphere. Products of combustion arising from the presence of short circuits in the apparatus pass up the flue.

**387,131. Electric Indicator;** Wm. A. Anthony, Manchester, Conn., Assignor to the Mather Electric Company, of same place. Application filed March 26, 1888. The object of the invention is to cause equal electric changes to be indicated by equal movements throughout the whole range of such an instrument. To accomplish this result the inventor opposes to the directing power of the stationary and movable helices the force of a weight, which is applied to the movable helix bymeans of a flexible connection running over a curved surface. See illustrations.

**(1) 387,145. (2) 387,146. Galvanic Boiler Cleaning Compounds;** Francis J. Calmer, Philadelphia, Pa., Assignor



387,131. ELECTRIC INDICATOR.

of two-thirds to Chas. Woltes and Joseph G. Hendrickson, both of same place. Applications filed Jan. 31, 1888. A composite metal, consisting of zinc and sometimes copper, is placed inside the boiler. Contact with the alkaline water sets up galvanic action and prevents scaling.

**387,160. Electric Rock Drill;** George Guntz, Wilkesbarre, Pa. Application filed June 30, 1887. The drilling tool is operated positively in both directions by the alternate attraction and repulsion of a single solenoid helix.

**(1) 387,194. (2) 388,194. Regulators for Electric Motors;** A. G. Waterhouse, Hartford, Conn., Assignor to the Waterhouse Electric and Mfg. Co., of same place. Applications filed Nov. 30, 1887, and May 25, 1887. (1) The speed is regulated by diverting a portion of the current transmitted to the motor through a locally closed circuit including one or more of the armature helices, and containing an adjustable resistance. (2) An auxiliary collecting brush is placed near one of the main brushes. A conductor including an adjustable resistance connects the main and auxiliary brushes. A conductor also connects the auxiliary brush through an adjustable resistance with the opposite main brush, and around the armature. By the rotation of the armature, a local current is set up between the last mentioned pair of brushes, including the armature coils between them. This local current increases with the speed of the armature and serves to alter the position of the magnetic lines in the armature, thereby limiting the speed. See illustration.

*Copies of the specifications and drawings complete of any of the patents mentioned in this record—or of any other patents issued since* 1866—*can be had for* 25 *cents. Give the date and number of patent desired, and address Johnston's Patent Agency, Potter Building, N. Y.*